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What Is Being Done in Soil Investigations and Subsoil Treatments

Facts About Behavior of Soils That Lead to Needed Cures

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THE designing and construction engineers of highways are both kept too busy in these days of $100,000,000 appropriations for road construction, to give any considerable time to research or the study of such a seemingly unimportant material as the soil beneath their road. They usually call it dirt. The dictionary tells us that dirt is matter out of place. Undoubtedly some of the soils encountered fall into that category. They are certainly out of place beneath our roads and from their uneasy actions they evidently are trying to get away from the road.

Engineers have long noted the uneven wear and maintenance upon roads, and especially noted the spotty nature of the wear upon the same piece of construction. They have laid it to the soil, seasonal and drainage conditions in conjunction with heavy traffic.

The problem of preventing this uneven failure has been attacked from several angles. First, the design of the pavement itself; second, the type of the pavement and the character of the material used; third, the improvement of the methods of pavement construction; fourth, the weight and design of the vehicles using the road; and fifth, the soil and methods of stablizing it.

This paper is to particularly discuss this latter phase, the soil and its treatment.

The soil problem has been left to the research laboratories to find why some soils cause foundation troubles and if possible to find a cure for the malady.

Needed Facts.—The engineer needs to know the textural composition of the soil, the extent of its plasticity, the amount of swelling and shrinkage it undergoes, the case with which it disintegrates in the presence of excess water and its capabilities to self drainage. These soil characteristics have been satisfactorily worked out in the laboratory so that the engineer can

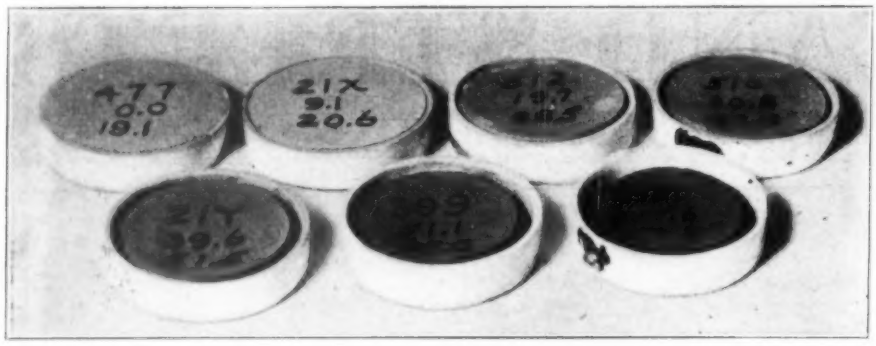


Fig. 2—Illustrates the Shrinkage of Seven Different Soils. The Middle Set of Figures Upon the Pats Show the Amount of Shrinkage by Volume. The Lineal Shrinkage Would Be About One-Third of the Volumetric

now be told how any soil responds along these specified lines.

It has been shown that as the texture of the soil becomes finer, the shrinkage usually becomes greater, the plastic nature of the soil increases, its capacity for retaining water has increased and its power to carry water away by gravity has decreased.

It has been shown that by making admixtures of sand to a clay soil it may be improved in stability until a very plastic, bad soil can be made into the excellent, sand-clay, road surfaces exhibited in Georgia and other southern states.

Effects on Pavement.—The manner in which these soils affect the pavement is as follows:—the shrinkage and expansion of the soil cause displacement of the pavement both vertically and horizontally; the shrinkage opens large cracks that admit surface water quickly, this excess water disintegrates or slakes down many soils into a plastic mass having but small load sustaining power; the heavy soil brings beneath the road by capillarity a large amount of water which by freezing and thawing, and by evaporation and condensation may be set free to mix with the soil by traffic vibration, thus seriously weakening the support beneath the pavement; and, finally, dense soils do not permit percolation or drainage by gravity.

You may question the fact that the small amount of pavement movement due to the swelling and shrinkage of soil can seriously affect the pavement, but let me call your attention to the report of the U. S. Bureau of Public Roads upon the California highway system, published in 1920; in table 23, page 78, this report shows that of the D, E and F classes of road surfaces, that is those showing failures of considerable moment, 70 per cent of the failures occurred upon adobe and clay sub-bases, against 30 per cent upon all other classes of soils. Those failures constituted 18.9 per cent of all the concrete pavement built upon clay and adobe soils. When you realize that some of our soils shrink as much as 50 to 57 per cent of their wet volume (132½ per cent of dry volume) in drying out, that is they will produce 20½ ft. of cracks in 100 lin. ft. of soil, then it may impress you with the force which some soils exert beneath a pavement. (See Fig. 1 and Fig. 2.)

Soils of large shrinkage open cracks so that when rainfall occurs, surface water finds easy access beneath the pavement, this disintegrates the soil at the most vulnerable portion of the pavement,—namely, the edge.

The finer the grains in any soil, the smaller will be the void spaces between them. This does not decrease the total void space per unit but simply cuts it into smaller divisions. Because of this smallness of void space there soon comes a limit beyond which percolation is impossible because of the extreme friction against the flow of water.

Good and Bad Soils.—The point at which a soil passes from one giving good support to one yielding poor support to a pavement, must of necessity depend upon several variable conditions, such as (1) the weight and amount of traffic, (2) the thickness of type of pavement, (3) the amount of water held by the soil, (4) the plasticity of the soil.

A given pavement upon a specified soil may carry 1,000 vehicles per day during the summer and fall, yet when the frost is coming out of the ground in the early spring it may break down under one-half that traffic. An 8-in. concrete road may stand with 2,000 cars per day throughout the year, whereas an 8-in. bituminous macadam may fail under 1,000 vehicles per day during the spring thaw, because the rigid pavement bridges over the weak soil while the flexible pavement does not. Tests seem to prove that an 8-in. flexible stone pavement transmits eight times the unit load to the soil beneath it that an 8-in. concrete pavement will transmit.

In order, therefore, to classify a soil as good or bad for subgrade purposes, the conditions it must meet should first be given.

Base Design on Worst Conditions.—In designing roads to meet certain traffic conditions, the unit load it is calculated to transmit to the soil should be based upon the bearing power of that soil at its worst possible seasonal condition. If it is a soil having high capillarity and a wide range of plasticity, then in road design either a low bearing value should be assigned to it, or special provisions made to keep the water content in the soil near the road down to a reasonable value. The Ohio State Highway Department has found that blind stone drains, generally known as French drains, constructed at about 30-ft. intervals along the road from the edge of the road to the ditch have been of great value in preventing the excessive softening of the subgrade.

In more extreme cases porous sub-bases of granulated slag, cinder or gravel have been qiute successful,—remembering the porous sub-bases should always be well drained.

The fact that soils are at their worst during the spring thaw has long been recognized by the highway departments by posting notices that loads shall not exceed 7½ or, in some cases, 5 tons per vehicle during that season.

Classification of Soils.—The classification of soils by tests in the laboratory should be positive and yet be simply made. Long involved tests have no place in the highway program. The tests should cover the various unstable characteristics, such as swelling, shrinkage, plastic range, fine grained character of the soil, its slaking rate and percolating value.

I shall not attempt to explain those to you, for you may read about them in Vol. 9, No. 1, Public Roads, for March, 1928.

There are some phases of these tests, however, that may interest you and serve to show you some of the marked characteristics of soils.

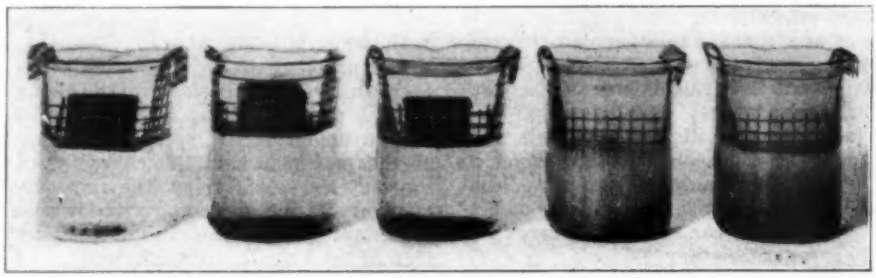


Fig. 3—Shows the Different Times in Which Various Soils Disintegrate in Water by Slaking. The Cylinder at the Left Would Take Several Hours to Slake Down. Those at the Right but 3 to 10 Minutes

I have already called your attention to the great variation in the shrinkage of different soils. Pure sand soils do not shrink. As the grain size passes below the .005 millimeter diameter shrinkage increases. The shrinkage of a soil is volumetric, that is, it shrinks in all dimensions, hence a soil that shows 20 ft. of shrinkage per 100 ft. can do great damage by its vertical movement of the pavement.

The slaking value of a soil is interesting because it varies so widely and the effects of it are so deadly if they occur beneath the edge of the road. It varies from one or two minutes to several hours. One important phase of it is the fact that a large number of the soils repulse further attack from water if their water hunger has been satisfied.

One of the later developments in soil analysis has been the use of the hydrometer to show the granular gradation of the soil. It gives a fine picture of the soil and renders the comparison of soils quite easy. (See Fig. 3.)

Coarse grained soils are easily drained, gravity drawing the water readily to the lower parts of the soil from whence natural or artificial drains can quickly remove it. As the grain size decreases the movement of water by gravity through the soil becomes slower and more difficult until such a fineness is reached that capillarity takes precedence over gravity and drags the water up as readily as down and will not permit it to be yielded to any free drainage system. When the latter condition is reached it is a waste of money to install tile or blind drains in order to drain the soil.

Conditions frequently occur which cause subgrade difficulties and which the engineer fails to notice at the time of design and construction because the weather is dry and the soil gives no indication. When wet weather comes the changed surface conditions after construction, or the increase of traffic, quickly expose the weakness.

The subsurface water brought to a road by a slight depression or swells may not be in evidence during construction but will show up in the spring thaw.

Inadequate Drainage.—The engineer may be constructing a road through a porous, granular soil that shows evidence of carrying water during wet weather. He provides side ditches or tile drains, but does not construct them deep enough to reach the impervious clay stratum beneath the top soil. In consequence when the wet weather comes, water passes beneath the drain to the under side of the road and destruction occurs, as shown in Fig. 4.

Fig. 4 represents this situation in the undrained section beneath the road at A B C which carries water to the under side of the road at O and P, whence the destructive action occurs.

The porous layer of soil does not have to be exceedingly open—but just

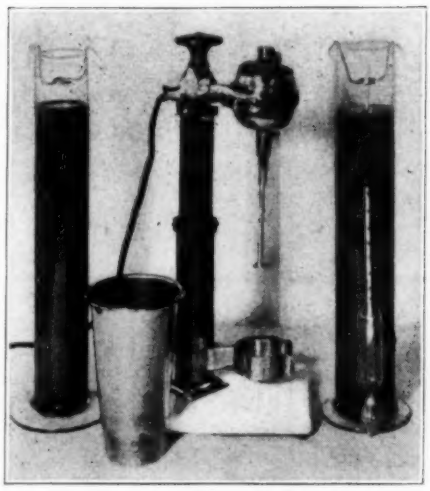


Fig. 4—Shows the Bouyouces Hydrometer Apparatus. The Center Piece Is Used for Dispersing the Soil, the Hydrometer at the Right Indicates the Amount of Soil in Suspension at Any Given Period of Time

open enough to permit percolation, while the denser layer beneath takes seepage much slower, thus storing water in the upper stratum to follow it to some lower point of attack upon the road.

The remedies for the above mentioned conditions are (1) eternal vigilance in noting slight changes in hillside slopes that will affect the flow of water towards the road, especially noting all slightly defined drainage courses; (2) the application of porous bases in some locations to collect and transmit the free water that occurs at those points; (3) the vigilant noting of the various soil horizons and the difference in texture existing between them, and the installation of drains at all horizon contacts between an upper porous stratum and a lower more impervious stratum where they occur beneath the road or immediately adjacent; (4) the noting of all seep points in cuts and providing special drainage for these special cases.

General Moisture Content.—The dense, fine grained clay soils draw water from great depths by capillarity. They will not yield it except by evaporation and freezing. Observations taken upon the top of a sugar loaf hill at the surface and at depths of 6 in., 12 in., 18 in. and 24 in. and compared with similar observations taken at six locations along the highways, chosen to represent normal conditions, showed that the hilltop soil carried a larger amount of water at practically all the depths and at all seasons of the year.

The average moisture for five different months during one year at the five depths for the hilltop was 23.9 per cent of the weight of the dry soil, while the average for the six stations along the road, which included 147 separate determinations, was 19.4 per cent, 4.5 per cent difference.

The hilltop soil contained 88.5 per cent of clay, while the other six soils contained clay varying from 43.7 per cent to 82 per cent in volume.

Probably the greater capillary tension in the hilltop soil would account for the increased content of water in that soil. Another factor may have been that the 6 in. of top soil had not been removed from the hilltop, while it had been from the road stations, and that this more porous top soil had maintained water in contact with the subsoil sufficiently long to completely satisfy its capillary demands.

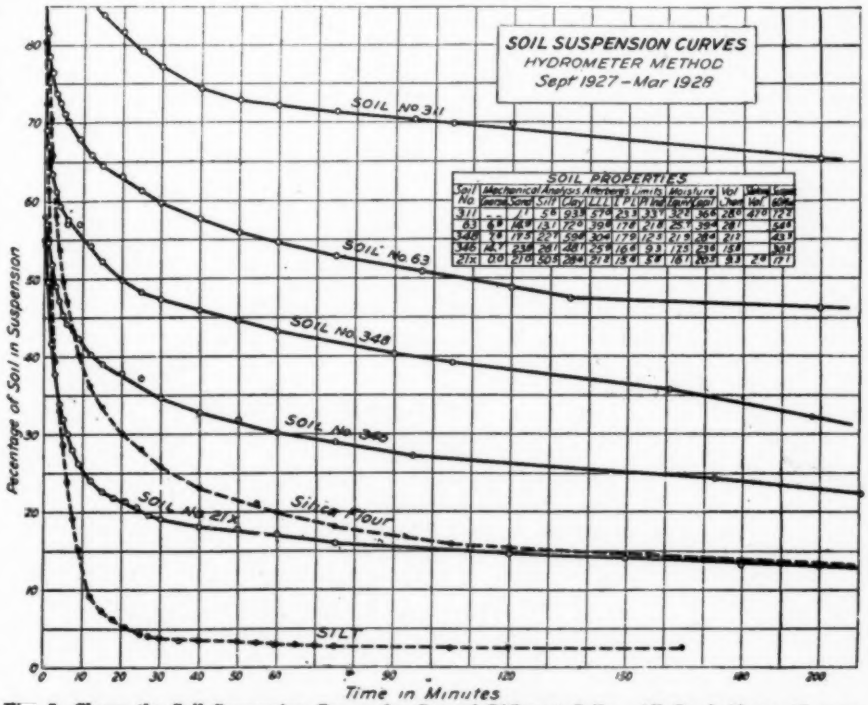


Fig. 5—Shows the Soil Suspension Curves for Several Different Soils. All Sand Above .05 m.m. in Diameter Settles Out Within Two Minutes. Practically All the Silt Settles Out in 25 Minutes. The Balance of the Material in Suspension Consists of Clay of Various Size Grains

Heaving of Pavements.—A study of pavement displacement has been made which shows that practically all of the Ohio pavements are in motion much of the time. Usually the greatest upward displacement occurs in January or early February and the settlement occurs rather quickly after the spring thaw. One year the total upheaval settled back in two weeks.

In some soils, however, the greatest upward movement has occurred in a mid-summer wet season.

The conclusions thus far drawn are that the largest displacements occur in winter and are due largely to the frost. Lesser displacements may be due to the swelling of the soil during long continued wet spells. (See Fig. 5.)

It is quite probable that both frost and soil swelling may take place at the same time. The largest displacement thus far observed in Ohio has been slightly over 3 in. The greatest depth of frost observed in Ohio since these observations began, early in 1925, has been 14 in.; this may account for the small displacement.

Much greater displacement has been reported from Michigan and Minnesota, where as much as 8 to 12 in. and more have been reported.

One phenomenon observed was the uneven vertical movement of the pavement along the longitudinal axis. This places the concrete slab under a considerable stress and may account in part for transverse cracks occurring at close intervals.

As a rule the pavement settles back in normal times to its original position. In the case of upheaval due to swelling soil the return to normal elevation is much slower than when due to frost.

Subgrade Treatment.—The first and most important effort should be to stabilize subgrade by well perfected drainage. The ordinary drainage conditions, such as small streams and the surface drainage from slopes are usually well met by the construction of culverts and side ditches. It is the sub-drainage complicated by the varying strata and textures of the soil that has escaped the engineer's notice and plans.

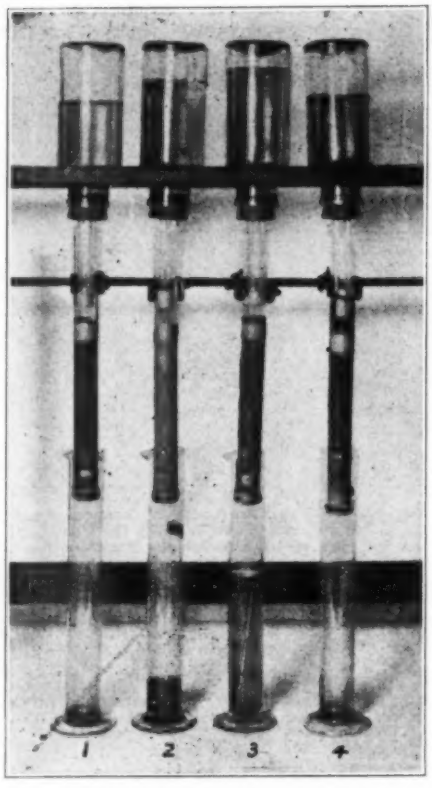


Fig. 6—Illustrates Percolation Test Apparatus. 20 c. m. of Soil Are Used. Water Is Maintained on the Top 2 c. m. Deep. The Amount of Water Which Percolated Through the Soil in Cylinder No. 1 was 4 c. c. in 10 Days; No. 2 Cylinder 34 c. c.; No. 3 cylinder, 2,000 c. c.; No. 4, the Water Had Not Reached the Bottom of the Soil Column in 10 Days

About two-thirds of Ohio, the western and northern portions, have been overrun by glaciers. The glaciers have left many deposits which are usually quite irregular with respect to thickness, slope and texture. Throughout this section, the drainage may be very erratic, requiring detailed examination to detect the sources of free water and to provide proper drainage facilities. These same conditions probably exist in many of the Central Western states.

These glacial effects are shown in Fig. 6. Note the mixed stratification and also note that where sand occurs between two impervious strata, water was brought to the underside of the pavement with the resulting failure of the road.

Fig. 7 shows the topography along one Ohio road and the results of having no intercepting drains. The seepage from the hillside is intercepted by a type of soil that permits it to be carried down and beneath the road with the result that the subgrade is softened and the road broken as shown. The answer to this is either drainage of the field above the road, or else properly placed drains along the ditch of the road that will cut deep enough to intercept the subsurface seepage.

One of the most insidious attacks by water upon the subgrade is made by capillary water which while not normally freed from the soil, may be freed by frost and evaporation as mentioned previously and become a serious menace. Thus far, the best method to combat this seems to be the laying of a 3 to 9 in. porous subbase beneath the pavement and draining it at frequent intervals into the nearby ditches or into specially constructed tile drains leading to natural outlets.

Porous Subbases.—Actual observation and a consideration of the laws of physics and mechanics lead to the following assumptions concerning the action of porous subbases:

1. Porous subbases increase the distance from the surface of the pavement to the subsoil and from an insulation layer beneath the pavement. This should reduce extreme temperature effects and maintain a more uniform temperature in the sub-soil.
2. They form a cushion layer and should reduce the churning effect of traffic which mixes the water and clay into a plastic mass.
3. They add depth of stable material which should distribute the traffic load over a greater area of the soil thus reducing the unit load upon the soil.
4. They provide large void space beneath the pavement to absorb the expansion when water freezes.
5. They act as reservoirs to hold free water collecting beneath the pavement until a sufficient volume has collected to drain away easily through drains which should be provided in all cases where porous bases are used.

In the order of their ease of handling for construction purposes, the materials for porous subbases fall into the following order, the first being best, granulated slag, cinder, crushed slag, crushed gravel or stone, worn gravel and sand.

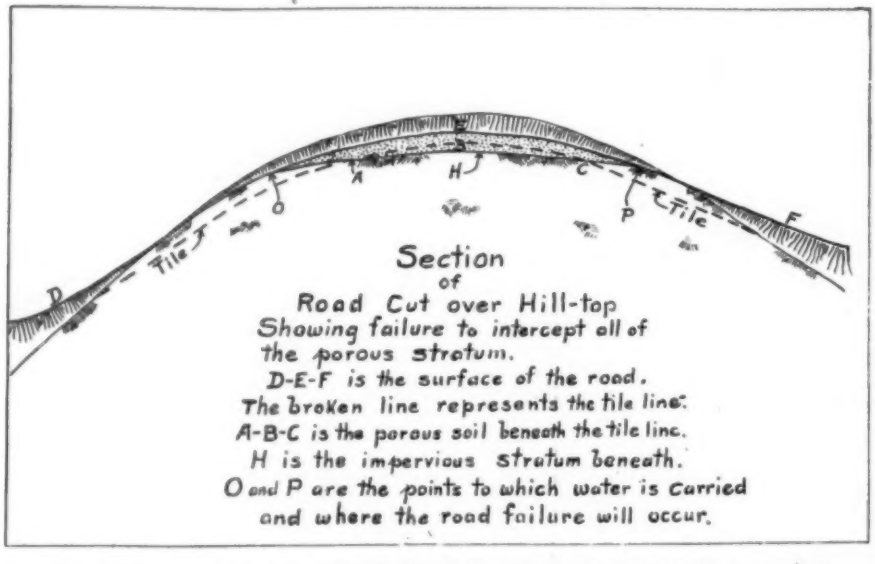


Fig. 7—Represents the Failure to Secure Complete Drainage Beneath the Road. The Figure Explains Itself

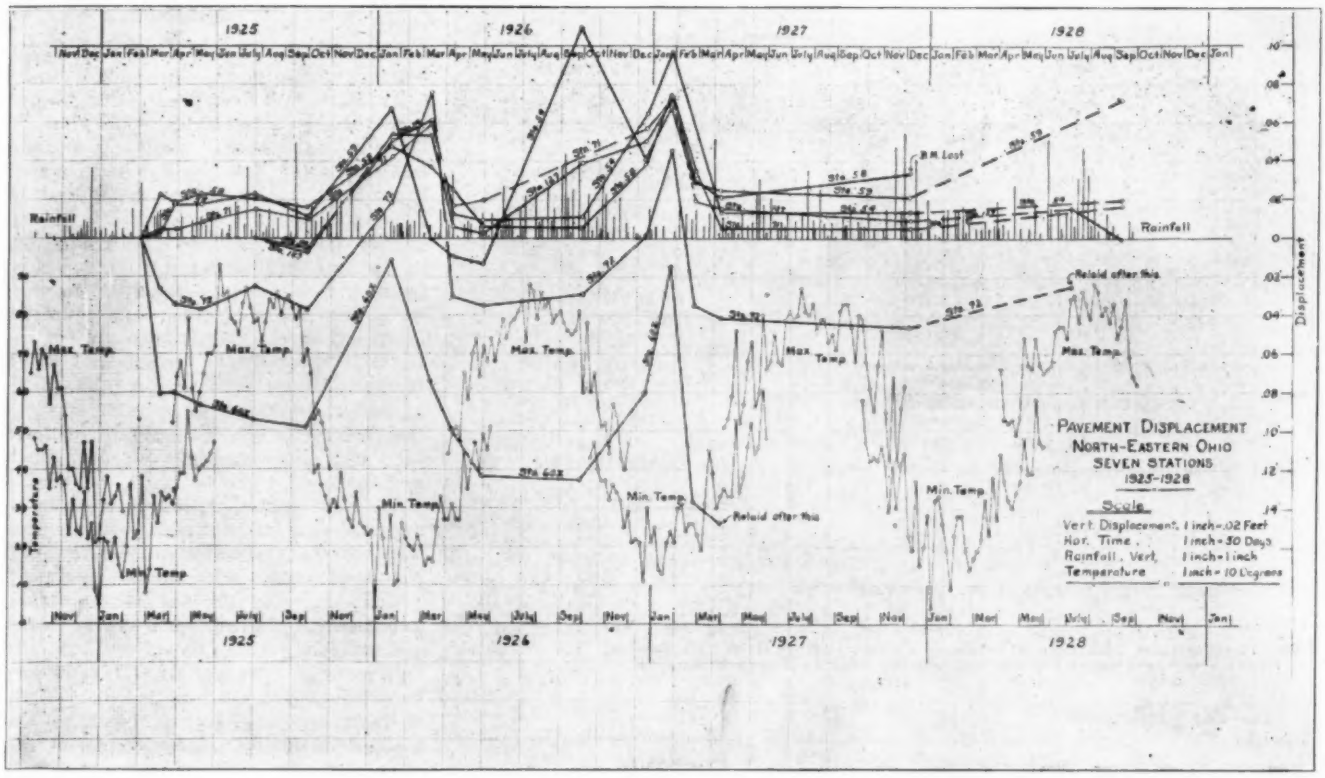


Fig. 8—Illustrates the Vertical Movement of Various Pavements Due to Swelling of the Soil or Its Shrinkage and the Effect of Freezing and Thawing Beneath the Pavement. The Figure Explains Itself

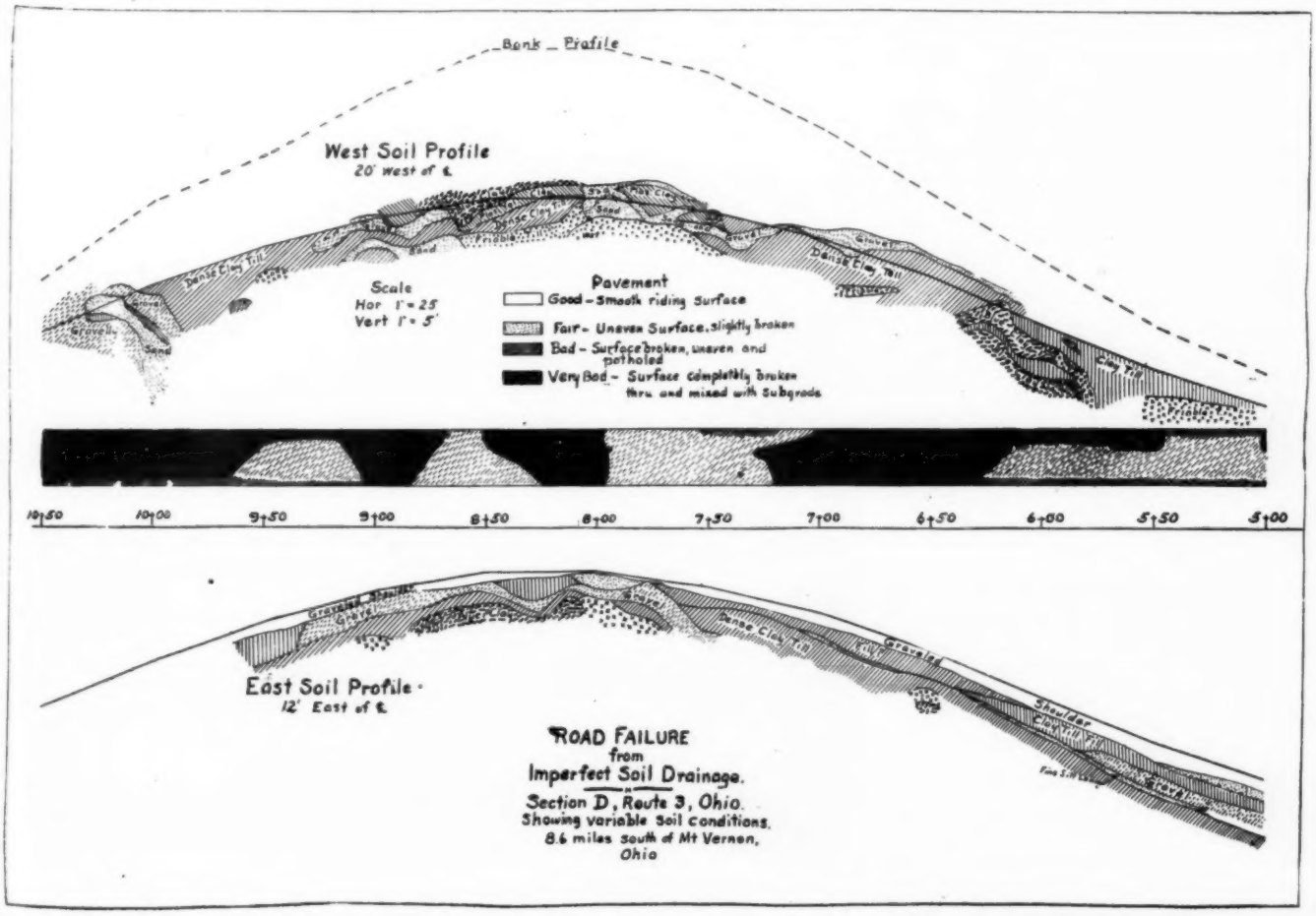


Fig. 9—Illustrates the Very Irregular Placement of Soils Due to Glacial Action. The Result Is Very Often Disastrous as Shown in the Above Figure

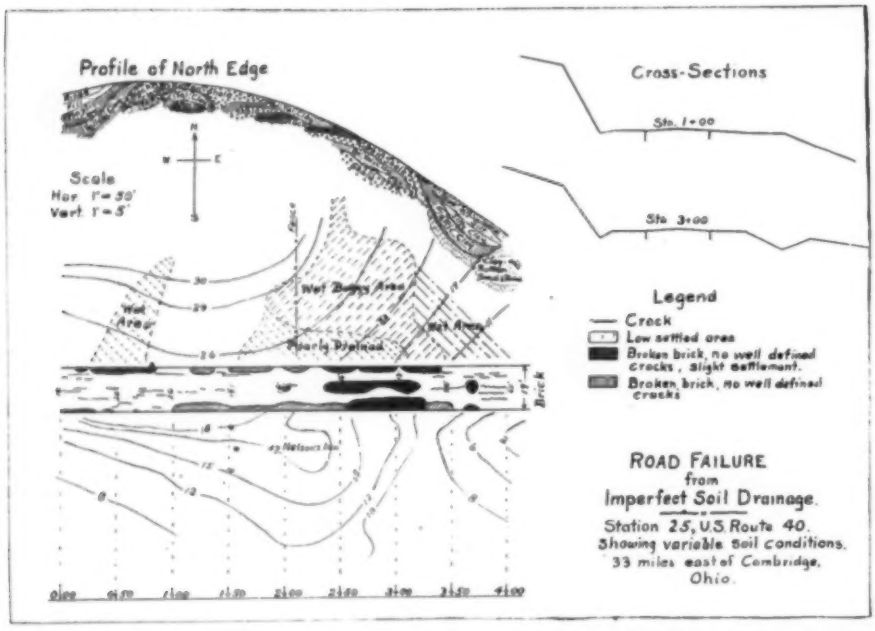


Fig. 10—Illustrates Both Glacial Action and Imperfectly Drained Side Ditches. The Wet Boggy Area Carried Water Beneath the Road Causing a Failure as Noted

Thus far granulated slag has proven the best for alleviating the soil troubles.

The economical thickness for porous subbases has not yet been determined. This will undoubtedly be governed by the plastic nature of the soil, the amount of water reaching the subbase, and the weight of traffic to be carried over the pavement.

Pavements have failed over porous bases, but no published reports are available to show whether all requirements were met, or whether failure might be due to other causes. However, the value of porous bases have been amply proven in many cases in Ohio, Rhode Island, Minnesota and other states.

Admixtures.—There may be a field for the use of admixtures to unstable soils, but under the permanent type pavements and under the climatic conditions in Ohio it is quite impracticable. The clay soil that needs the treatment will ordinarily be turned up in immense chunks while gradings, which will not break up due to the tenacity of the clay.

If dry weather could be counted on during the construction season, then admixtures might be made. For, by the use of the blade grader, the subgrade soil could be pulverized and then admixtures made and mixed with the soil by the use of disc harrows.

Thus far only Portland cement and hydrated lime have been used in Ohio. The experimental trial of $CaCl_2$, oils, sands and other chemicals are contemplated. In the use of oils only those of extremely low viscosity are available.

There have been sufficient data collected to yield any conclusions, other than the impracticable nature of the use of admixtures that require the clay soil to be pulverized.

Treatments.—Under the head of treatments may be included the use of such agents as do not require mechanical mixing with the soil. Such as the application of oils to the surface with the idea that they will penetrate into the subgrade soil and alter its actions and character; or the application of dry chemicals with the expectation that the water which causes the subgrade trouble will dissolve and carry the chemical down.

No such treatments have been made beneath our high type pavements.

Traffic Bound Roads.—In Ohio we are constructing many miles of what is termed traffic bound roads. The road bed is graded and the drainage structures built. A thin layer of small sized crushed slag, stone or gravel is bladed across the road bed, leaving a windrow of the material at each edge. Traffic is maintained and as it drives the material into the subgrade, more material is bladed across the surface until a resistant, substantial surface has been formed. Some soils take 4 in. to 6 in. of material and two seasons of application before they become stable. Others take but one season's work and much less material.

We have begun, therefore, a series of experimental treatments to determine whether it is possible to secure more economic results with the heavier soils.

Cold tar, cold oil, asphalt emulsion, kerosene, used crank case oil, Portland cement, $CaCl_2$ and hydrated lime are being tried. It is too early to draw any conclusions yet.

However, we have found that the asphalt emulsion and cold oil do not penetrate the soil but formed a mat upon top of it, which was not what we were seeking. The mat will probably prevent the gravel being driven into the soil and will interfere with the proper blading of the surface. We hope to try many of these treatment methods upon the subbase of the more permament types of pavements at an early date.

Acknowledgment.—The above paper was presented at the 7th Annual Asphalt Paving Conference.

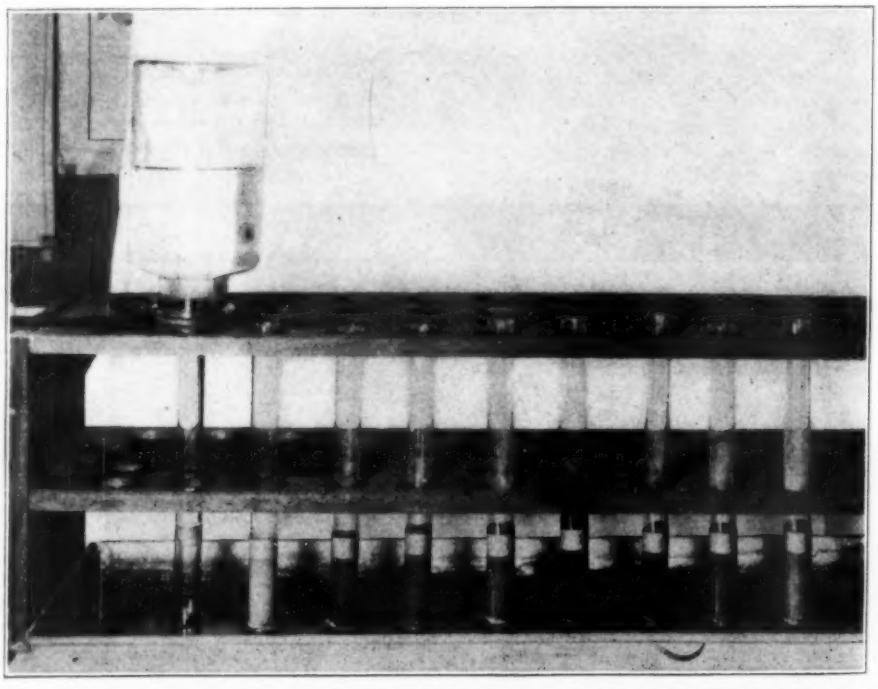


Fig. 11—Shows the Apparatus for Obtaining Capillary Capacity of the Soil. Note That Some of These Soils Have Swelled to a Marked Degree Above the Top of the Band

The Elimination of the Hazard of the Railroad Grade Crossing

A Suggested Method for Rational Classifying

By E. W. JAMES

Chief, Division of Design, U. S. Bureau of Public Roads; Chairman American Road Builders Association Committee on Grade Crossings

THE existence of railroad grade crossings presents one of the largest and most perplexing of the problems that must be met and solved in future highway programs. The ideal highway will be without grade crossings, just as it will be free from objectionable curvature and gradients, and it will have adequate width and sufficient strength at the edges to carry traffic over its full width.

The grade crossing problem forces itself on our attention because of its tremendous magnitude, its terrible inherent dangers, and because of the increasing inefficiency in highway service that grade crossings involve as traffic increases.

Fatalities Due to Grade Crossing Accidents.—Other features of the design and the condition of highways are likewise responsible for accidents in considerable number and for numerous fatalities. New York State reports for 1927 more motor vehicle accidents due to other road conditions than to grade crossing collisions, but only 29 fatalities following such accidents. Compare this with 151 fatalities involving motor vehicles reported by the Interstate Commerce Commission as occurring at grade crossings in New York State. If these figures may be accepted as complete we find grade crossing accidents represent 329 out of 1,159 accidents which may be attributed to faulty conditions of road design or 28 per cent; while fatalities resulting from such accidents at grade crossings numbered 151 out of a total of 180, or 84 per cent. Crossing accidents are in the State referred to approximately three and a half times as hazardous to life as other accidents due to faulty design.

It is not possible to push comparisons of this sort very far, however, because of the methods used for reporting the facts and the possible incompleteness of the record. Such statements should be accepted only as indications implied in the available data. Some of these accidents were not principally due to the condition of the highway or to the mere presence of a grade crossing. The Interstate Commerce Commission reported for 1927 that on the steam railways of the United States 1,148 out of 4,818 motor vehicle accidents were the result of automobiles being driven into the sides of trains, at times breaking through gates or passing clearly visible danger signals. Such accidents involved a powerfully contributing element of carelessness, and undoubtedly the same element is present in accidents reported by New York and other states as due to road defects.

Grade Crossing Treatments First.—We cannot say, therefore, that among defects of design the railroad grade crossing is the most dangerous to any definite degree, but the indications are reasonably certain that it is more dangerous and they are more conclusive that the degree of hazard to life is greater than in the case of any other faulty elements in our current highway design.

We are apparently justified therefore in putting grade crossing treatments first in our list of details to receive attention.

The solution of the problem cannot be approached by a money valuation of lives saved. If each death cost the railroad $10,000, the total cost per year would be $23,710,000. To eliminate all crossings at an estimated unit cost of $75,000, which is conservative, the total investment would be seventeen and a half billion dollars, which at 6 per cent would cost the railroads more than one billion per year or about 50 times the saving in damages. This allows ample margin for damages due to accidents resulting only in injury.

The matter cannot be approached from the point of view of savings in railroad operation. The trains do not stop for crossings now, and their elimination therefore would not save appreciable time. The saving in crossing maintenance as compared with the maintenance of structures would be negligible as compared with the cost of the structure.

For the reason that it would obviously disrupt operation and destroy railroad service entirely, it is neither feasible nor just to compel all trains to stop at grade crossings and so create a condition which might be construed as justifying grade crossing elimination. The railroads cannot carry the cost as a part of a general betterment program. For instance, the Southern Railway, through its Chief Engineer's Office, made an estimate of the cost of eliminating all crossings on its lines. The cost slightly exceeded the present total value of the railroad system and all its property. To make such an investment judiciously it would have to foresee savings or additional income from new business equal to its present income; or else increase its operating efficiency beyond any reasonable expectations. Either of these is totally impossible.

If we assign half the cost to the public, the solution on any basis mentioned still remains impracticable of justification.

What the Solution Involves.—Without going further with suppositions of this sort, I submit the constructive proposition that the way to meet the problem involves the following:

(1) A definite classification of crossings based on the relative value to the traveling public of their elimination.

(2) A definite annual program by each state and each of the railroads in each state, for the elimination of certain grade crossings of highest classification.

(3) Restriction of the authority to create new grade crossings.

(4) A definite progressive program in each state for installing safety warning devices of a rigidly standardized type or types.

(5) The readjustment of the share of the cost of elimination and of the installation of safety devices between the railroads and the public.

Fixing the Value of Eliminating a Grade Crossing.—Each of these items requires detailed consideration in this report. We must first determine some method of fixing the value of eliminating a grade crossing. Here again we may not evaluate the saving of life. Some of the busiest and apparently most dangerous crossings have surprisingly good records. Other innocent appearing crossings of single track, jerk-water branch lines have records that are terrifying. The records of Maryland and Delaware indicate that relatively more accidents occur at grade crossings with roads not on the state system, than at crossings with state roads. Obviously, we cannot adopt a plan of valuing elimination, based on actual accidents, on lives lost, or on location if these state records may be depended upon for data. It would lead us directly to the elimination of crossings on our least traveled roads at the expense of the main road system; and this cannot be the proper general solution.

In taking this attitude I do not in-

tend to minimize human life in the slightest degree. I am simply following logically the thought that any basis of life valuation will not serve any basis pose of classifying railroad grade crossings. When we devise a plan and a program of elimination and protection, savings in life and property should by the laws of probability be the direct result in proportion to the execution of the plan.

Difficulty in Securing Necessary Data.—At this point let me say that all attempts to devise a scheme for classifying grade crossings on the basis of their relative danger or relative inherent hazard has failed, because it is practically impossible, from any group of records available today, to secure individual crossing data. It is not practicable to fix a value to condition of approach, angle of crossing intersection, type of pavement, gradient of approaches, number of tracks or other details of the sort. There are no adequate records to show how any of these characteristics of a grade crossing affect its degree of hazard.

The commonest current idea is that the hazard of a crossing may be considered as varying directly with the traffic, rail and highway, passing the intersection. This may appear entirely reasonable but this also is not supported by such data as we have in detailed form. It is impossible to divide existing crossings into urban and rural classes, into those on state systems and those on all other roads; or to make any useful classification of such crossings for the country as a whole. The committee knows that some railroads have such information in their records, and other roads probably have it also. One road offered to undertake not only a classification by location with reference to the state highway system, but also to locate accidents at the individual crossings. It was calculated that it would take at least three months to get the material out of the records and analyzed. The Interstate Commerce Commission reports furnish no data useful to a plan of classification such as we are seeking, and undoubtedly the information has never been collected by many railroads.

Vehicle Time Lost at Crossings.—To determine the relative value of specific eliminations, therefore, it is suggested that a purely economic study be made on the basis of time lost at crossings under assumed conditions of entirely safe operation. From the railroad point of view this must be acceptable, because the expense of stopping, as indicated by increased cost of operation and loss of time, is the reason why trains may not be stopped at all such crossings. Although the losses of a similar nature in the case of a single motor vehicle are only a small fraction of those incident to a train stopping and starting at the same crossing, the number of units involved in highway traffic are so great that in the aggregate the loss is considerable.

If the railroads protest the stopping of their own traffic as expensive and destructive of efficiency, they must recognize it as having a similar disadvantage to highway traffic. Some studies of such losses have been made and several cases are cited in Table I to indicate what they may amount to.

Similar studies made by Mr. F. Lewis Lavis in connection with certain stoppages at drawbridges on the New Jersey approach to the Holland Tunnel indicate losses so great as to warrant the elimination of the bridges by tunnels under the Hackensack River, or the additional cost of high level bridges that will obviate the stopping.

Lost Time and Efficiency of Highway.—From these analyses it is quite clear that cases can exist where there is a distinct and considerable loss of time to the public flowing directly from the grade crossing. On such crossings the time which is lost may be stated in terms of the efficiency of the highway as follows:

Case 1, above cited, indicates a highway 86 per cent efficient, the reduction from full efficiency being due to the existence of the grade crossing. Case 2, above cited, is 79 per cent efficient. Case 3, is 95 per cent efficient, and Case 4, 90 per cent, and so on.

This condition does not, however, represent the total loss of efficiency of the highway due to the grade crossings. In some states, notably North Carolina, Louisiana, Mississippi, Florida and Nebraska, there are crossing stop laws, requiring all approaching automobiles to come to a full stop before entering the intersection. In some cases the law requires a reduction of speed to a rate at which the automobile will be completely controllable within a few feet. The speed fixed in Nebraska on secondary crossings is 12 miles per hour. These laws apply to all traffic on all roads of the state and represent if observed, another source of lost time, required in an effort to attain safety at grade crossings. If such methods are adopted in all states the total losses in highway service will be enormous.

The ratio of night to day traffic using the period from 7 P. M. to 7 A. M., indicates that the vehicle hours loss may be increased by 50 per cent to arrive at the 24 hour loss. In the cases cited these full day losses would be respectively 35.4 vehicle hours, 69, 18.1, 45.9, 35.5 and 24.6. If we assume that the use of an automobile is as valuable as its operating costs we are very conservative in assigning one dollar an hour as the cost of the lost time. The above losses, so charged and capitalized at 6 per cent would justify expenditures of $215,350, $419,750, $110,108, $279,225, $215,958, and $149,650.

Classification of Grade Crossings on Rational Basis.—The recital of further conditions is unnecessary to convince us that there is here a method by which all grade crossings may be classified on a rational basis. This applies as well whether the crossing is protected by gates or watchmen or whether it is wholly unprotected. In general, it may be applied by taking a traffic census and computing the losses due to that kind of motor vehicle operation that will reasonably produce complete absence of accidents at the crossing. At the present time little or none of these data are available except in a few cases studied more or less as experience or in connection with other problems than grade crossing elimination.

It should be noted that here we have developed the soundness of the idea that the value of eliminating the crossing varies directly with the amount of rail and highway traffic, but not with reference to the idea of hazard involved. The value of elimination is referred directly to a measurable economic loss. Further, it should be noted that this is by no means the same as establishing the degree of hazard by assuming that it varies directly as the

Table I—Vehicle Time Lost at Selected Grade Crossings in Cleveland Regional Traffic Survey

Road	Railroad	Location	Highway traffic 7 A. M. to 7 P. M.	Rail traffic 7 A. M. to 7 P. M.			Time blocked 7 A. M. to 7 P. M. hours	Vehicles stopped	Per cent of time blocked	Per cent of vehicles stopped	Ratio of clearance time to time crossing is blocked	Total vehicle time loss, vehicle hours
				Passenger trains	Freight trains	Switch trains						
East 72d St.	N. Y. Central	West end Gordon Park	4,799	2	12	4	.89	319	7.4	6.6	1.18	16.4
Lorain Avenue	N. Y. Central	Near West 143d St.	5,955	44	4	36	2.48	1,867	20.6	31.4	1.22	46.0
Broadway	Wheeling & Lake Erie	At Union Avenue	14,220	6	—	27	.62	600	5.2	4.2	1.38	12.1
East 93d St.	Erie	Near Meech Avenue*	4,372	13	7	22	1.20	709	10.0	16.2	1.31	30.6
East 93d St.	Wheeling & L. E. (Pa.)	Near Meech Avenue*	4,372	6	11	18	1.18	650	9.8	14.9	1.24	23.7
U. S. Rts. 20	Nickel Plate	West of Painesville	7,752	27	17	31	1.69	1,078	14.1	14.0	1.24	23.6

*Crossings approximately 300 feet apart; blocking of one crossing impedes traffic at other.

product of train and highway traffic. This is clear from the brief record given in which 7,800 vehicles and 75 trains create practically the same cost of delays as 4,400 vehicles and 33 trains.

Having made such a classification, based largely on highway traffic density, we should be in a position to arrange each year for a reasonable program of grade crossing elimination. It might not be possible to include each crossing in its exact order, but the relative importance of elimination would be known and the program would be defensible.

Number of Grade Crossings Increasing.—The record of grade crossings in existence shows that the number is actually increasing in spite of a constant and growing program of elimination. This condition results from the ill-advised creation of new crossings, in many cases quite unnecessary. In 1924 there were 232,710; in 1925, 233,701; in 1926, 235,158; and in 1927, 235,446. At present the authority to create new grade crossings lies usually with the administrative body authorized to open or to accept newly opened roads. Such authority should be confined to the state highway department, or to some state public utility commission and new crossings should only be permitted where the need is demonstrated as sufficiently great, and there no other route or solution is possible at the time.

As indicated under the item discussed above it will certainly not be possible to adhere rigidly to the schedule or classification of crossings based on the evaluation of delays and costs of operation, and consequently some grade crossings must be left in place more costly as economic feature, and probably more dangerous, than others which will be eliminated. To insure that the hazard here involved may be reduced to a minimum, even if the economic loss may not be remedied, it is proposed that on the basis of the same classification a program he instituted of installing regularly standardized safety devices. The plans of the several devices should be uniform for all highways and for all railroads. They may constitute gates with or without watchmen, watchmen alone, lights, wig-wag signals, gongs or other devices; but in each case the installation and the operation should be as nearly uniform as possible. Studies must be made of the probably relative efficiency of the various installations. For instance, a comparison of the crossing accidents for 1925, 1926 and 1927 shows that in 1926 accidents increased 8.1 per cent with gates, 6.2 per cent with watchmen, 13.8 per cent with signals and 6.4 per cent without protection; and in 1927 they decreased 15.4 per cent with gates, increased 0.5 per cent with watchmen, increased 4.3 per cent with signals, and decreased 6.6 per cent at all other crossings. But here again, as in so many cases based on existing available data, our information is not complete, because there is no statement of the traffic involved at the crossings and consequently the increase of accidents per 10,000 vehicles passing the point is not necessarily the same as the percentage relation of the number of accidents. Undoubtedly the most effective form of protection can be reasonably determined if the highway authorities will undertake the studies required, and some form or forms of protection can be fixed as most likely to prevent accidents.

Each of the programs of treatment may be subdivided by railroads, a program being arranged with each road based on its ability to appropriate toward the cost. Further subdivision of the programs may, and no doubt should, be made on the basis of urban and rural crossings, there being a program for each type.

Readjustment of Costs.—Finally some more or less definite readjustment of costs between the railroads and the public should be made for all grade crossing treatments. At the present time the cost of installing protective features is borne by the states entirely in some cases, in others entirely by the railroads. The costs of grade crossing elimination are in some states not specifically allotted by law, and in other states range from 50 to 75 per cent allottable to the railroads. If we are to base a program of elimination on a classification based on economic saving to highway traffic, it appears logical and fair to be liberal in the allotment of costs to the general public. Certainly this attitude will make it possible to speed up the entire program of elimination and protection.

Finally a word must be said about certain features of eliminations by structure and of installations of safety warning devices that are not now generally acceptable to the railroads. Central bents in underpasses must be omitted unless the highway has four lanes of traffic, and then must be made as safe as possible by the separation of the roadway into lanes for traffic for some distance in each direction. The separation must occur far enough back to be effective with little danger to traffic. Skew crossings must be more freely used, especially in underpasses in order to provide clear and long sights on the approaching highway. Safety devices must not be installed in the center of the highway, but at the sides.

Progress in New York State.—The proposal for definite annual programs based on a rational classification of grade crossings has already received favorable attention. The New York State law under which grade crossings in that State are being eliminated with the proceeds from a bond issue of $300,000,000 requires that a definite program be set up each year. One of the largest railroad systems in the United States has already voluntarily adopted in five States a policy of annual programs in co-operation with the respective State highway commissions and the plan is working satisfactorily to both parties interested.

In connection with the fact that so little data are of record that is useful in determining some details of the programs, it is recommended that each State highway department undertake, through a designated official, to collect accident figures and analyze them in form to show the urban and rural crossings, accidents at each and resulting fatalities; the types of protected crossings, their location, and accidents and results at each. This information will permit setting up separate urban and suburban programs, and enable a decision to be made as to the effectiveness of the several types of protection where immediate elimination is not possible.

To summarize the thought presented in this report it should be noted that the evaluation of intangibles is neglected and a method suggested that permits of an exact determination of economic losses measurable by stop-watch methods. Any reasonable valuation can be assigned, and so long as it is the same it serves to fix the classification of the grade crossings and eliminates relative error in such classification. Then by assigning the actual value of delays, which, if necessary, may be assumed to be different in different places, the cost of actual elimination may be justified in cases where the economic loss is sufficiently great. The element of human life and the damage to property is not actually neglected for their protection will flow as a by-product from the eliminations made, and in as great a degree as can be determined by any less exact or rational method of selecting grade crossings for elimination.

Acknowledgment.—The foregoing is taken from a committee report presented Jan. 16 by Mr. James at the 26th Annual Convention of the American Road Builders Association.

Michigan Highway Engineering Conference.—The 15th annual conference on highway engineering will be held at the University of Michigan, Ann Arbor, Mich., Feb. 19th to 22d, inclusive. Among the speakers from outside the state are R. M. Smith, Deputy Minister of Highways, Ontario, Canada; Robert Kingery, General Manager, Chicago Regional Planning Association; P. J. Freeman, Chief Engineer of Tests, Allegheny County, Pennsylvania, and Robert H. Ford, Assistant Chief Engineer, Chicago, Rock Island and Pacific Railway. At an evening session Dr. William H. Hobbs will give an illustrated lecture on his recent Greenland expeditions.

Important Factors Encountered in Highway Maintenance in Urban Counties

Summary Report Presented at Convention of A. R. B. A.

By GEORGE C. WRIGHT

County Superintendent of Highways, Monroe County, Rochester, N. Y.

THE problem of highway maintenance in urban counties has always been a serious one due to continually changing traffic conditions and types of construction. Attempted planning for future requirements from experiences of the past may not be wholly satisfactory.

Accurate records covering sufficient information necessary for purpose of application and comparison of costs are unavailable. The following report covers to a limited extent some of the more important factors encountered in Urban County Maintenance.

In dealing with the various factors mentioned in this report no attempt has been made to discuss in detail specific methods for actual performance of maintenance work on urban county highways. It does try to point out the principal features of this work with a few details which are necessary to satisfactory maintenance; and in general how to accomplish them.

The information has been obtained through separate reports furnished by various members of the urban county maintenance committee located over a wide territory. Each member has dealt with a separate subject, thus considerable diversification has been secured.

Cooperation in Large Population Centers.—With rapid development in large centers of population and the extending of city boundaries, cooperation between the control units is obviously necessary, otherwise confusion, duplication of efforts and needless expense is bound to result.

The city and county officials should be informed as to what each is doing and is contemplating.

Most cities have more or less complete organization in charge of city planning and zoning, some have gone into the study of traffic conditions, present and future, in great detail, reaching out into adjoining territory with their studies. Similar bodies organized in counties and towns and cooperating with the city organizations are bound to be desirable and can be made very effective.

Further cooperation can be obtained by publicity, by interesting civic organizations and by keeping the public informed as to what is going on in the way of highway development.

Selection of Type of Maintenance of Improved Roads.—Usually there is necessary a balancing of available funds with needs. The most economical procedure is that which will adequately serve traffic at the least cost per ton mile. Consideration of such costs brings in the question of vehicle operation costs and loads which may be carried, as well as the actual maintenance costs.

As to how much should be spent is difficult to determine without information on the number of factors, such as volume of traffic, weight of traffic, frequency and duration of peak loads, condition of road, availability of materials and labor, desirable changes and the consideration of more or less complete reconstruction.

It would seem that with a good foundation and good drainage, or conditions which make good drainage possible, the maintenance of the surface is the thing to do; building up on and making use of what is already in place.

In this connection, a more careful study of existing pavement conditions and a more careful supervision and inspection of actual maintenance results and costs are strongly recommended.

Selection of Type of Maintenance for Poorer Class Roads.—The object of maintenance operations is to prolong the life of the road, provide easier riding, reduce wear and tear on vehicles, eliminate the dust in dry weather and mud in wet weather and, last but not least, cut down present and future maintenance costs.

These objectives cannot be attained except by continued improvement and by utilizing what is worth while in the existing road. If there is nothing worth using, the best procedure is reconstruction by stages; that is, by improvement of drainage, construction of a substantial base of sufficient width and doing these things in first class shape.

In the selection of type of maintenance for the less expensive class of roads, the main feature which limits the work is lack of funds. Treatment, with bituminous material has been, in many sections, used very satisfactorily.

A comprehensive study of the condition and needs of these less expensive roads should be made and a program covering a period of years fixed upon.

How Maintenance of Urban Highways is Affected by Width of Pavement and of Right of Way.—Narrow pavements cause concentration of traffic, which wears the pavement mainly on two lines, and frequently causes ruts. On wider pavements the traffic spreads out, relieves concentration and decreases wear. While the area to be maintained is greater, the actual work is less.

Traffic can frequently be kept moving while maintenance is being done on wide pavements. This is usually impossible on narrow roads where the public suffers inconvenience and delay.

The width of right of way has an influence on maintenance. If the right of way is of substantial width, say five to six times the actual width of pavement, it is possible to correct improper drainage conditions, curves and grades and to increase sight distances. Right of way of sufficient width should always be procured prior to initial construction and when values are low.

In areas adjoining large centers of population it is frequently considered good practice to construct full width pavements with curbs and gutters. This is much more sightly, maintenance cost is less and travel is safer.

Drainage of County Highways Adjacent to Large Centers of Population.—This is one of the most important features in satisfactory highway construction and one which has frequently been neglected in the past, making necessary the improvement in this respect as a part of maintenance. The continuance of improper drainage conditions decreases the value of otherwise satisfactory maintenance.

When drainage difficulties are encountered a careful study should be made covering the subsoil, the surrounding terrain, the opening of ditches and the necessity of deepening or enlarging of existing waterways.

Where maintenance on a large scale is undertaken a comprehensive plan should be prepared with a view of storm water sewers replacing open ditches. Culverts should be investigated and made adequate as to size, depth, width, grade and strength of floor system. This also applies to bridges. Culvert and bridge designs should be pleasing in appearance, as in some localities bridges and culverts form a considerable part of the landscape. Grades of ditches, so that they will be self-cleaning, is important.

Brush and weeds should be regularly cleaned out.

Under certain conditions sub-grade drainage is necessary, and frost conditions should receive attention.

Open ditches are increasingly undesirable as population and travel increase. In the substitution of pipe for

open ditches care should be taken to get proper grades, and size of pipe. The error, if any, should be in getting pipe too large rather than too small.

Removal of Snow on Urban County Highways.—This is a problem which varies greatly throughout the country. Where heavy snow is the usual winter condition there is a distinct loss to a community where movement on the highways is restricted to about eight or nine months of the year and the highways are blocked with snow for the remainder.

In the organization for removal of snow the following factors must be considered:

1. The size and topography of the county.
2. The mileage and location of roads to be cleared.
3. The machinery and equipment available.
4. The amount of snowfall.
5. The direction and velocities of prevalent winds.

Frequently in large counties, very different conditions are experienced in different parts.

The utilization of road building machinery for snow removal is very common even when augmented by special units.

Motor trucks from 3½ to 5-tons capacity and 5 and 10-ton tractors each provided with plows, are the usual items of road building equipment used in removing snow.

Straight blade plows for trucks and V-type plows for tractors seem to be the usual thing.

Various types of purely snow cleaning equipment are now in use with varying success.

Equipment is but a part of snow removal; organization is more important. Headquarters, gangs, repair men, shops, continually ready for instant movement make for adequate snow removal.

Snow fence is a very important preventative of drifting. The board type is gradually being replaced by the picket type.

Fence is usually placed where experience shows the likelihood of drifting, sometimes in two rows on the usual windward side and sometimes as a precaution on the opposite side of the road.

It is recognized that a few deep drifts frequently will give more trouble than many miles of undrifted roads. Money spent on well placed fence will often save many times as much as the cost of snow removal.

Cutting of woods and brush has been found effective in preventing of drifts.

Underground Installations Within Highway Boundaries and Their Control.—The cutting of pavements and shoulders and interference with drainage conditions by uncontrolled installation of water, gas, sewer pipes and electric conduits cause serious maintenance difficulties.

Where laws do not afford means of control, legislation to that end should be secured. Permits should be required, bonds should be furnished by those doing such work, inspection should be provided and time limits for the work should be set.

Uniformity of workmanship and procedure are desirable but with varying conditions the best that can be expected at present is coordination between city and adjoining counties.

Maintenance of Urban Highways by Different Methods, Such as "Contract," "Force Account," and "Patrols."—Where county forces are busy with an extensive program of construction and reconstruction and require the use of all of their man power and equipment, it is necessary to find some method such as contract to take care of the maintenance. If maintenance is to be done by contract sufficient funds must be available.

Difficulties are likely to develop in maintenance by contract because the details cannot be anticipated as in construction specifications. An inspector should be employed on all contract work.

Patrols are commonly employed continuously on roads carrying a large volume of traffic and where continuous attention is required and their value has been demonstrated on lighter traffic roads. The size of these patrols vary from one man and light truck to foreman, several men and trucks, rollers, spreaders and oilers.

Because small failures in roadways are quickly corrected by the patrol system extensive reconstruction can frequently be postponed.

As stated above, a competent foreman with an experienced gang and sufficient equipment can do patrol maintenance as well and cheaper than it can be done by contract.

Work done under force account method is usually more extensive and more nearly approaches reconstruction than the work of patrols.

As in other branches of highway work cooperation between officials is absolutely necessary to get the best results.

Route Marking and Direction Signs.—Standardization of highway signs is very important and the adoption of a standard method or rather standards for national, for state, and for local systems are essential for proper routing of traffic.

The American Association of State Highway Officials has adopted standard types for use on highways, and, together with the Bureau of Public Roads, have published a manual and specifications for the manufacture, display and erection of U. S. standard road markers and signs.

A copy of this publication can be obtained from the Bureau of Public Roads at Washington, D. C., or the American Road Builders' Association. The intent is to "produce uniformity of significance in the signs themselves and make familiarity with them easy to acquire on the part of the most casual driver."

Each shape and color combination has its particular significance.

The octagonal sign is used to bring the approaching vehicle to a stop.

The diamond shape means slow.

The circular sign is used exclusively as a notice of a railroad grade crossing.

The square sign designates caution.

The rectangular sign, other than the square, is used to carry directions, information and restrictions of use or benefit to the driver.

The arrow shaped may be substituted for the rectangular for directional purposes.

Route markers on United States Highways take the form of the official U. S. shield. On state highways, not U. S. Highways, various states have adopted appropriate forms, such as the sunflower in Kansas, the triangle in Wisconsin, and the keystone in Pennsylvania and others. Several states use the state outline as a distinctive marker.

In the matter of color, black designs or letters on a yellow ground are used for caution; black on white is used for direction, information and restriction signs, the same is recommended for route markers.

Symbols for railroad grade crossings, for curves and turns and the arrow are recommended.

It is suggested that where a different type is desired by a state that the cooperation of the Bureau of Public Roads be secured in the devising of a standard sign.

The various signs are described in detail and shown in color in the manual.

Care of the signs is as essential as their erection; cutting of overhanging limbs of trees to increase visibility is frequently overlooked.

The lighting of signs at night will receive more consideration in the future.

Of the various methods of sign location, such as overhead, alongside and on pavement, the signs erected alongside of the roadway seem to be best.

Traffic Control on Urban County Highways.—Speed and volume of traffic make traffic control necessary. The objects to get maximum volume past a given point in the shortest time, consistent with safety.

This can be accomplished by diversion so that centers of population may be conveniently reached by many routes rather than one route; by widening of existing roads, which is less expensive than parallel routes, but does not serve as many people; by separation of traffic at intersections of heavily traveled roads,—this may be advisable where both roads carry 15,000 to 20,000 vehicles per day; and by segregation of truck and passenger traffic.

Parking restrictions aid in making more of the road available for traffic.

Danger signs restricting speed in vicinity of schools, large factories and

points of congestion tend to decrease accidents.

"Stop and then Go" signals and flash signals at busy intersections also aid in prevention of accidents.

All these methods of control are sometimes looked upon by the traveling public as nuisances. Therefore, these signals should not be used except where the need is unquestionable.

Effect of City Traffic on Urban County Highway Maintenance.—City traffic increases the cost of maintenance operations and at the same time makes the actual work more difficult. It also makes necessary more adequate traffic control and restrictions than are required for purely local traffic.

City problems must be considered on rural highways and drainage conditions make necessary a more complete study and expensive construction.

Suggested Model Organization for Urban County Highway Maintenance.—The formation of a model organization for maintenance of urban county highways must be of necessity influenced by conditions which are quite different in different localities with variation in maintenance materials, equipment, employees, funds and purely local requirements.

Assuming that the county superintendent or similar official has under his charge the construction, reconstruction and maintenance of the roads of a county adjoining, or containing a large city and with sufficient funds to keep a maintenance force going, then the following organization is suggested.

The governing board of the county would have two committees on this work; one, the good roads or highway committee, whose duty it is to provide funds, institute a general policy for the carrying on of highway work; and to act as advisory to the country superintendent; another, the county planning committee, which cooperates with a similar organization within the city. It lays down a general policy as to planning subdivisions for future development. This committee cooperates with and advised by the county superintendent of highways on matters of widths of right of ways, probable extensions, drainage and zoning.

The highways department, of which the maintenance bureau is a part, would be constituted as follows: The county superintendent of highways, who is the executive of the department and advises with the highway committee on matters of policy. The securing of adequate funds and such other details as should properly come before them are also included.

Under the county superintendent are an office and field force.

The work would be carried on about as follows: The county superintendent would during the year make a general survey of needing attention in the coming year. He would make estimates of the ways and means for performing this work. This data would then be discussed with the highway committee. Careful estimates would then be prepared and submitted in the form of a budget to the committee. The committee would then see that the tax levy provides for the estimates.

These estimates and plans are checked and rechecked to the end that all possible contingencies may be met. The construction and maintenance departments will then know what is to be done and how the work is to be handled, and they will cooperate without loss of time in the working season.

The above outline would, of course, be modified to suit conditions but could be used as a suggestion as to a model organization.

Future work of this committee should include studies of traffic, service and costs of maintenance on the various types of roadway in common use. The cooperation of all county officials in this work is strongly urged.

Roads Into Large City Subject of Systematic Study

What is believed by many authorities to be the most scientific plan of systematic highway improvement yet developed for the environs of a large city, according to the Bureau of Public Roads of the United States Department of Agriculture, is described in detail in a report just published by the County Commissioners of Cuyahoga County, Ohio, in co-operation with the bureau.

Based on a traffic survey, conducted by the commissioners and by the bureau, the 10-year plan of improvement of highways in Cleveland and its tributary area in Cuyahoga and adjoining counties, includes the construction of new through routes to join disconnected sections of present highways. It also includes the development of belt highways around the city, the widening of many present routes, the construction of a viaduct over an industrial section to provide a direct approach from the south to the center of Cleveland, the construction of several bridges over the river valleys which have heretofore imposed serious obstructions to direct traffic flow, and other extensive changes. The estimated cost of the improvement is $63,000,000.

A mass of data was produced by the survey concerning the average and maximum density of traffic on all important highways, the origin and destination of traffic, the most direct routes for larger traffic movements, and the causes of habitual departure from such routes where it was found that the movement was not following the direct route. It also shows the habitual speed of traffic and conditions influencing speed and causing congestion, such as grade crossings, street car tracks and loading platforms and traffic lights, the convergence of heavily traveled highways; the width of pavement required to accommodate various traffic densities; the possibility of establishing new routes which would relieve congestion on present routes and which would provide more direct communication between various areas.

In recent years, the outward movement of population from Cleveland has caused a rapid growth of the suburban section, according to the bureau. At the time of the survey there were 49 small municipalities in Cuyahoga County alone, in addition to Cleveland, Lakewood, East Cleveland and Cleveland Heights. More than 39 per cent of the area of the county is included within the limits of these cities.

Each of these urban communities has partial jurisdiction over sections of the county highways within its borders, and the lack of a common plan has been a serious obstacle to continuous and consistent improvement of the main highways. This condition coupled with the rapid increase in traffic finally resulted in congestion so serious that the Federal bureau was called upon to suggest a remedy.

Upon agreement that authorities in the whole area, including those of seven counties and of the 49 municipalities of Cuyahoga County, would cooperate in carrying out a 10-year plan of highway improvement, based upon a detailed survey of present traffic and estimated future traffic, the bureau agreed to conduct such a survey in cooperation with those authorities and also with those of the State Highway Department.

Copies of the report may be obtained by state, county and municipal authorities and other responsible persons by application to the Bureau of Public Roads, Washington, D. C., or to the Board of County Commissioners of Cuyahoga County, Cleveland, Ohio. It contains full details of the traffic survey and of the proposed plan of road improvement.

Frank T. Sheets Reappointed

Frank T. Sheets has been reappointed Chief Highway Engineer of Illinois by Governor Louis L. Emmerson who recently took office.

Mr. Sheets has been associated with the Illinois Division of Highways for the past 22 years, and for the last eight years has been the chief engineering and administrative officer of the Division.

He is a past president of the Mississippi Valley Conference of State Highway Officials and the American Association of State Highway Officials, and a member of the American Society of Civil Engineers.

During the past eight years, Mr. Sheets has supervised the design and construction of road and bridge work costing approximately $250,000,000.

The Personnel and Equipment of a State Highway Maintenance Organizatian

How Missouri Maintains 267,600 Mile State Road System

By C. P. OWENS

Assistant to the Chief Engineer Missouri State Highway Department, Jefferson City, Mo.

HIGHWAY programs have attained such proportions during recent years that it has become necessary to devote careful study to administration, organization and equipment problems in order to insure wise and economical use of the funds provided. The users of the highways constitute practically the entire population. Their demand for good highways and highway conveniences call for an enormous yearly expenditure of public funds. The public places faith in the men charged with the spending of these vast funds and pleads that it be spent wisely, economically, and where returns will be greatest.

Maintenance is one branch of highway work where the public has the greatest opportunity to observe the spending of this public money. This, of course, is due to maintenance employees and equipment being evenly and widely distributed over the whole highway system, and working the year 'round in constant sight of the traveling public.

Money properly spent for maintenance gives quicker returns on the investment than any other expenditure for highway work. Maintenance is popular or unpopular according to the scale of efficiency and inefficiency of the organization. Consequently, since the maintenance employee is ever under observation by the passing public, and the efficiency of the entire highway organization is judged by the impression he creates, it is of vast importance that each maintenance employee be selected, trained, directed and instructed with the greatest of care.

Maintenance Defined. — The word maintenance, strictly speaking, does not contemplate any improvement of the original existing conditions. However, the term maintenance as applied to highway work cannot be restricted in its meaning. It must be more broadly defined. As applied to highway work, maintenance is defined as a term covering the work of repairs and replacements necessary to preserve the original investment, together with the addition and betterment work to meet economically the growing demands of the traveling public for better service, and the special work necessary to satisfy the traveling public's demand for safety, convenience, and service.

Analyzed carefully, we find this definition covering a wide field of activity. To those who are engaged in maintenance work, the field is rapidly extending with no definite limit in sight. The duties of maintenance men, or patrolmen, are many. There is the hard manual labor to be performed in all kinds of weather that requires hard muscles and the determination to stay with the job. There is the work to be performed alone on isolated sections where the patrolman is on his own honor, and where he must use his own initiative. There are times when he comes into direct contact with the traveling public under trying circumstances and when self-control, tact and diplomacy must be exercised. There are times when he must be sent on missions of diplomacy, where he, in working clothes, among his own people, accomplishes results where others have failed.

Small Size Barber-Greene Loader Being Used to Dispose of Surplus Dirt Pulled from the Ditches and Windrowed Along a Gravel Road. Cleaning Ditches Along Gravel Roads Often Presents Quite a Problem in That the Dirt Cannot be Disposed of on the Surface, But Must be Picked Up and Hauled Away. With the Loader the Dirt May Be Cast Back of the Ditch Line or Dropped Into Trucks

The patrolman is the department's representative in the community in which he lives and works. The state highway commission is judged competent or incompetent by the community according to the standing of the patrolman serving the community. Consequently, it is important a man be selected to patrol the highways who is able not only to accomplish the necessary manual labor, but who is also able to work and conduct his personal affairs so that he creates in his community a favorable impression for the entire department.

One of the most important features of highway maintenance in this modern day of transportation is the maintenance of the highway markers and warning signs. Highways must be properly marked and hazardous places protected by proper warning signs. To be effective this marking must be uniform and in strict conformity with the U. S. standards. If marking is to render the fullest service, it must be continuous and never broken or interrupted. For this reason detours must be marked as well as maintained, and this rule applies equally well in cities and towns as in the rural districts. It is especially important that city, county and state officials co-operate closely in marking detours. When it is necessary to close a marked street for repairs, it is criminal to do so without marking a detour over suitable streets for the benefit of traffic unfamiliar with the local conditions. No public official can afford to commit any act which will lose the public's good will, but should do his utmost to create and hold the good will of the traveling public. This can be done by carefully marking detours, especially when streets are closed in cities and towns.

The question of maintenance in all its activities and angles is too great to cover in any one paper, or at any one delivery. Therefore, this paper is confined to the combined subjects of maintenance personnel and equipment. The various states have similar maintenance organizations, except for slight modifications to conform to the laws under which each operates. In discussing personnel it is necessary to include to a certain extent organization, and here the writer must confine his observations and experiences to the Missouri State Highway Department.

Organization.—The Missouri State Highway Department has been extremely fortunate in that the Highway Commission has functioned without political interference, and the Department has been allowed to operate under almost ideal conditions. The State Highway Commission of Missouri is composed of a bi-partisan board of four members; two each from the two major political parties; one member serving as Chairman and another as Vice-Chairman. The State Geologist is an Ex-Officio member. The Commission

selects the Chief Engineer, who selects all other employees—subject to the approval of the Commission. Employees are selected without reference to political preference or religious belief, and are promoted or discharged in the same way. Ability and past record are the sole merits for employment and promotions.

To perform the vast amount of work necessary in maintaining the Missouri state highway system of 7,600 miles, it is necessary to gather together a large organization. In order to insure efficiency, it is necessary that definite responsibility for the work be clearly established. For the purpose of designating this authority the state was divided into ten divisions with a division engineer in complete charge of each. In the maintenance organization each division is further subdivided into districts, with the roads in the districts divided into patrol sections. The division engineer, under the instructions of the engineer of maintenance, working under the direction of the chief engineer, is assigned general supervision of all work in his respective division.

An assistant division engineer in charge of maintenance, working under the general direction of the division engineer, is assigned to the direct charge of all maintenance work in each division.

The districts within a division consist of one or more counties or portions thereof, and a district foreman is in charge of all the routine work within his assigned district. The roads within the district are divided into patrol sections of various lengths according to type, and a patrolman is in charge of each section. The patrolman may work alone or he may have one or more helpers regularly employed, and such extra labor as necessary.

There are from ten to twelve counties and from 650 to 880 miles of road in each division. In the beginning the county unit was the district unit, but as type of roads were changed, it was found expedient to assign a portion of the road system in one county to the supervision of another county, and gradually the districts were enlarged to include more than one county. As a rule each district foreman is assigned from 80 to 140 miles of road, depending upon the type and character of improvement and the general layout of the road system.

Patrol sections vary considerably in length, depending upon the type of road and other features, but the following will suffice as a general guide. Team patrols on earth and light traffic gravel vary from 7 to 9 miles in length; motor patrols on earth and light traffic gravel vary from 14 to 16 miles in length; motor patrols on improved gravel and earth vary from 12 to 14 miles in length; gang patrols on paved roads, 20 to 35 miles in length.

Assisting each division maintenance engineer there is usually a division foreman, whose duties are confined mainly to directing the work on special jobs, and the gang work of special crews. The division maintenance engineer is either a technically trained man or a practical trained engineer of long experience. The division foreman is usually a non-technical man, but a man who is thoroughly versed in practical road work and has the ability to direct gang and crew foremen and their forces.

Of course, office help is provided in each division in the form of stenographers, bookkeepers and clerks, but none of the district foremen are provided with office help or space.

Employment of Forces.—Employment of competent and reliable men is the main secret of the success of any organization, and consequently, considerable attention and effort is directed towards the securing of capable, energetic and reliable men to act as district foremen and as patrolmen. It is imperative that every position in maintenance work be filled by able, industrious and competent men. The remark is often heard that an incompetent patrolman causes more adverse criticism than an employee in any other branch of highway work. The jobs of district foreman and patrolmen are really workingmen jobs, and it is very necessary that an explanation of the nature of the duties of each position be made to those seeking the position, in order that the applicant will not be misinformed and placed in positions for which he is not suited. As a rule, such men were obtained from within the communities in which they are to work. In a few instances where local organizations attempted to designate a man for the position irrespective of the man's qualifications, or where local factions were so strong as to prevent the employment of a satisfactory man, a man was obtained from another community and moved in on the job.

In employing a man, physical ability, character, alertness, judgment, past record and his desire for the job, were the fundamental points considered. Such men were obtained by inquiry directed to the attention of local authorities and local people who were interested road boosters; special effort being made to avoid consulting political leaders who might be more inclined to recommend a man for his political affiliations rather than his ability to meet the above requirements.

It has been found good practice that the district foreman be permitted to locate and interview several applicants for a particular job. He then submits the applications to the division maintenance engineer, who interviews the applicants, investigates their past records and makes sure the applicants understand the duties expected and that the best qualified man is selected for the position. This personal interview generally shows up the applicants qualifications, especially as to their ability to keep themselves physically fit for duty.

Employment of relatives of men already at work has been avoided in the Missouri State Highway Department. This has been found to be an excellent policy, and one to be recommended to any organization, particularly a public organization. Early in the beginning before this rule was adopted, a few relatives were employed and practically every case resulted in trouble and grief to the department.

All maintenance men are required to sign a working contract and furnish a personal bond. The contract insures that the men understand fully their duties and the hours of work expected prior to accepting the job. The bond is attached to the contract and covers agreement between the department and the applicant, and is so worded that it may be used to recover loss through negligence or intent. However, these personal bonds are used mainly to insure the employment of reliable men only. Experience has shown that un-

A Method of Preventing Ditch Erosion by Installing Creosoted Baffle Boards at Intervals so That the Drop from One Board to Another Does Not Exceed 2 ft. The Boards are Placed Vertically, Extend 3 ft. Into the Ground and Are Held Down by Means of a Header Board at the Top

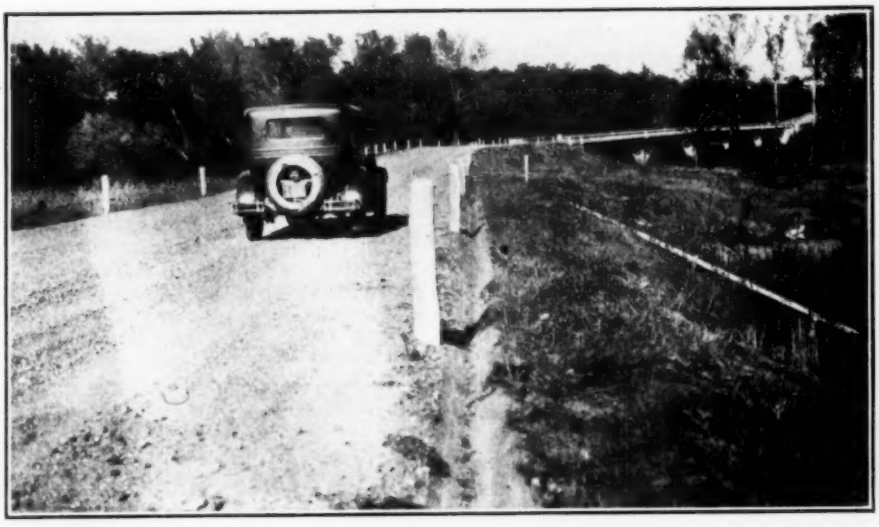
reliable men can quite readily secure letters of recommendation, but as a rule only substantial men and men of good standing in their community can go to the substantial citizens and secure a personal bond for the sum of $500. As a result of this policy, very little trouble has developed on account of men going wrong.

It is not necessary nor desirable that highway work be dependent on politics and subject to change with each political change in the state. Highway construction and maintenance in the last few years has grown to enormous proportions until it is one of the state's and nation's largest industries. For this reason alone it should be allowed to function on strictly business principles. Furthermore, politicians must stand or fall on the records as established. Better records can be made in highway work by directing an efficient non-political Highway Department than by directing an inefficient political organization. The average technical man or engineer only blunders when he attempts to play the political game, and since engineers are essential in a successful highway department, the department functions far better when organized and operated free from politics.

Directing an Organization.—After competent men are employed the real problems of organization are only begun. There remains the much more difficult problem of training men to their duties, of instructing them to make reports, of familiarizing them with the policies of the department, and of instructing them in the care and operation of the equipment assigned. After a man is fully acquainted with the policies, instructions and requirements, he becomes an asset to the Department.

After being employed, the new patrolman is given a digest of the more important instructions that aid him in becoming a successful patrolman. The more important of these are as follows:

1. An employee must never appear on the work under the influence of liquors or drugs.
2. He must provide himself with proper clothing for his work.
3. It is better to be safe than sorry.
4. No one other than state employees shall ride on maintenance equipment.
5. Children must never be permitted on or near equipment in operation.
6. Missing, damaged or impaired markers and signs must never be passed by without making effort to repair same.
7. After crossing maintainers over railroad tracks, flangeways must be inspected and cleaned if necessary.
8. Well kept equipment and good maintenance go hand in hand.
9. Red "Danger" flags must be always properly displayed on all equipment.
10. Warning flags, and "Men Working" signs must be displayed 400 ft. in advance of any work on roadway, and then only when work is in actual progress.
11. Closed roads must be properly barricaded, and barricades well lighted at night.
12. During emergencies, such as storms or floods, the patrolman must hold himself in readiness for group duty and be ready to assume the lions share of responsibility and work.



A Method of Preventing Erosion from Surface Water on a High Fill Built of Soil Readily Eroded. The System Consists Merely of Building a Wooden Trough Gutter of Creosoted Material Built in the Shoulder Flush with the Ground—Building Run-Off Troughs at Frequent Intervals and Protecting the Entire Structure by Means of Guide Posts Set Inside the Gutter

The average patrolman needs aid, help and advice as to how he can best perform his various duties. The division maintenance engineer must keep in close personal contact with all his field forces and must be resourceful and observing in handling his men. The division maintenance engineer who can clearly explain details in language understood by working men, or who can explain a short cut method or how to do more work with less effort, is immediately judged by the patrolman as a first class engineer. The division maintenance engineer who drives up, passes out a few orders, and drives on, leaving the patrolman puzzled how, where and when to start, wins but little respect for his actions. There is a vast difference between the work of construction and maintenance. As a general rule, the contractor wants but little advice on how to proceed from the construction engineer, and all he asks is a clear understanding as to the results desired. On the other hand, the patrolman wants to know the results desired, but he also wants to know how to proceed. From general observations, it is noted that the patrolman is always pleased to accept suggestions offered in the proper spirit.

Care must be used to avoid conflicting and confusing instructions. Road building and maintenance is a science best understood by all except those who are thoroughly schooled in the art. There are usually several good ways of doing any particular job. If the patrolman receives instructions from two sources, very likely he will be told two different ways of doing the work. In addition to the two sets of instructions received, very likely he has ideas of his own. Since the so-called authorities may differ in opinion, the patrolman has a perfect right to assume his own methods as sound as theirs, and will act accordingly, sometimes with questionable results.

Therefore, the division engineers have been warned to avoid giving instructions directly to the patrolmen or foremen in the field unless the division engineer and the division maintenance engineer have a thorough understanding. The division engineer should inform the division maintenance engineer of his desires. If the matter is routine work the division maintenance engineer will pass the instructions direct to the district foreman, who in turn passes them direct to the patrolman.

Instructions should not be passed down as coming from the above, but should be issued as coming direct from the immediate source. In other words, the district foreman should not inform the patrolman that the division maintenance engineer received word through the division engineer that the chief engineer desired a certain job done. Established lines of authority must be maintained and orders should pass direct through each source so as to strengthen each step in the organization.

Special car should be used so that too many orders are not given out at one time. The average patrolman is able to absorb only a limited amount of instructions and if maintenance orders are issued simultaneously, very likely the result will be confusion.

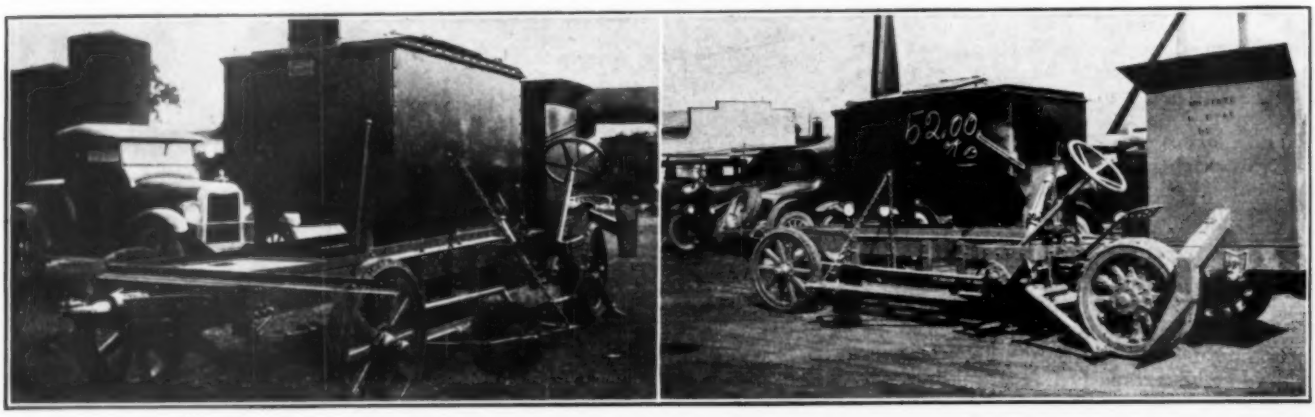
Salaries Paid.—The Missouri Highway Department has nearly 900 men in its maintenance organization, including division foreman, district foremen, gang foremen, tractor operators,

grader operators, special patrolmen, mechanics, patrolmen and helpers. These men are all paid a monthly salary and are required to work a specified number of hours each working day. Some states prefer to pay on an hourly basis, but it is found more convenient to check time if the working hours are uniformly fixed and understood. Patrolmen understand they must be on the job during the specified working hours and that no excuses are accepted unless permission has been given previously for leave of absence, or because of bona-fide sickness.

possible to pay salaries to fully compensate men for loyal and faithful service, especially in times of emergency. Instead, compensation must be derived from the satisfaction of having done the job well and in the knowledge that extra efforts are appreciated by the department and by the traveling public.

Various methods are devised and used in keeping up interest in the work, of building up the morale and of creating good fellowship within the department. The strict rule of making promotions from within the organization handling the various kinds of work, he becomes more valuable to himself and to the department, and his compensation should be adjusted accordingly.

Each field employee is entitled to two weeks' sick leave annually. Ordinarily, field men in the maintenance department are not entitled to an annual two weeks' vacation period, but where men have been with the department several years and have not used their annual two weeks' sick allowance, or where men have worked unusual and long hours, the division engineers may, with discrimination, allow these men leaves



Two Views of a Stripe Painting Machine for Painting Centerline Stripes on Concrete Pavement. The Machine Consists of an Old Truck Chassis, on Which Is Mounted a 300 Gal. Asphalt Kettle with Kerosene Burners. On the Rear Is Mounted a 1 cu. yd. Sand Box. The Outfit Is Towed Behind a Truck. Driver Steers from a Seat Mounted Directly Over the Rear Wheel. The Nozzle, Which Applies a 5-in. Width Stripe, Is Directly Opposite the Rear Wheel. Slight Irregularities in Steering the Front Wheels Affect the Results Very Slightly. Front Sight Adjustable on Front End of Truck Chassis. On the Rear End of the Tar Kettle Is an Adjustable Rear Sight. The Rotating Brush, Asphalt Nozzle, Sand Chute, the Seat, Steering Wheel and These Sights Are All in Line. The Outfit Is Operated by Trailing Behind a Truck, and the Driver Maintains His Centerline Position by Sighting Forward at the Centerline as Constructed in Our Pavements. Curves Are Marked by Using a Plumb Suspended from the Front Sight. For Instance, in Passing Around a Curve the Man Can Shift This Plumb—Keeping It a Few Inches Outside the Centerline, Thus Allowing the Nozzle to Apply Asphalt at the Proper Point. A Little Practice on Curves and the Men Soon Become Proficient

Rates of pay have been standardized so as to avoid complaints from various parts of the state that others are receiving more for similar work. Titles have been standardized and defined, and the duties under each enumerated.

It has been necessary to adopt a standard schedule for rural sections and a separate schedule for industrial sections. The industrial schedule averages from $15 to $20 per month more than the rural schedule to meet the higher local wage scale and higher living costs in industrial districts. Following is a list of salaries as paid at this time:

	Per Month
Division Foremen	$170 to $200 and actual expenses
Gang Foreman	140 to 165 and actual expenses
Gradermen and Tractormen	105 to 125—daily allowance $1.00
District Foremen	135 to 160 and actual expenses
County Foremen	115 to 135—no expenses
Head Patrolmen	105 to 115—no expenses
Patrolmen	80 to 100—no expenses
Helpers	70 to 85—no expenses

It has always been the policy to keep the rates of pay in line with the wages paid locally for work of similar nature, making due allowances for special ability, loyalty and length of service. As the average salaries paid gradually reach the upper limit, then the schedules will be revised to avoid having any salaries fall outside the fixed limits.

Keeping Up the Morale.—It is not

is followed. A man without pride and ambition does not normally stick to maintenance work, and the man who has no interest in his work other than his salary check finds the duties too hard, the hours too long and the regulations too strict to make his job attractive. However, men with pride and ambition must be afforded proper encouragement within the organization. Therefore, promotions to better jobs provided in the department must be filled from the ranks.

At least once each year consideration to salary adjustments is given and every employee in the department is given consideration for possible salary increases. The men who have shown ability and have produced results are rewarded with slight increases in salary. An attempt is made to handle each case individually, and to allow increases only when actually earned. As the employee becomes familiar with the policies, rules and regulations of the department and with the methods of

of absence to compensate them for their good efforts and for their overtime. Very few of the men desire to take advantage of this offer, except for occasional days when they may desire to attend local fairs, picnics, family reunions, etc.

Keeping the Men Interested.—The problem of keeping the men interested is one that is most difficult to solve. Very often it is found that the new broom sweeps clean and that new men do exceptionally well for a time, but suddenly lose interest, with results that are reflected almost immediately in the condition of their sections. The division maintenance engineer has a wide field to exercise his ability in the handling of the various problems connected with his field organization. The patrolman must be kept interested, and he must not lose his enthusiasm. He must remain content but ambitious. Every man is different; some men respond best to suggestions, some need only encouragement; some need friendly interest in matters probably foreign to road work, and some need an occasional plain talk from one specially gifted along that line. The division maintenance engineer can probably do more than any other individual in keeping the men interested and enthusiastic about their work. If the division maintenance engineer can successfully instill enthusi-

asm into his men, develop in them a pride in their work and a feeling of good fellowship and fraternity among the men, he has gone a long way in successfully executing his job of maintaining the highways under his supervision.

From time to time meetings or schools of instruction are held in each division. Some times only the foremen are present, but at other times all men are present. At these meetings no opportunity is lost to instill into the men loyalty, enthusiasm, interest, and good fellowship.

At least once each year each division holds a two or three day meeting for all employees. At these meetings the various bureau chiefs and others specialized in certain lines of work talk to the men on their problems, and the men are encouraged to ask questions and enter into discussions. Every effort is made to answer the most, apparently trival questions and to help the men with what to them are serious problems. These meetings terminate with a banquet, where none of the frills of entertainment, noise and fun are overlooked. The banquet soon warms up to the point where the bashful, hard-working men and would-be dignified white collared bureau chiefs loosen up and really get acquainted. These banquets are events that provide topics for conversation for the field men throughout the following working season. Affairs of this kind pay big dividends. Here the men become acquainted and friendships are developed to the point where the men are reluctant to quit highway department work for other fields.

A View of a Stage of Construction Used to a Limited Extent in Missouri on Lighter Traffic Routes. The State Has Built Some 9-ft. Pavements on the Lighter Traffic Routes—Believing that a 9-ft. Pavement Extending All the Way Is Better Than an 18-ft. Pavement Extending Only Half Way. In Order to Make the Pavement More Serviceable the Unpaved Portion of the Traveled Way Has Been Oiled

Group Insurance Plan.—Highway work is proving to be more and more hazardous as traffic increases in speed, weight and volume. Some of the highway work is hazardous in itself. A public employee, unlike any other, is without protection or recourse. The Commission has the power to offer but little except sympathy to the injured or killed and the dependents.

As a result of this condition, several of the divisions organized a mutual sick benefit association among the employees. Recently the main office canvassed insurance companies for a group accident policy that would afford the desired protection for the men at a rate which all men could afford regardless of low salaries. A policy was selected and each division formed an association, elected its own officers; and, practically all employees adopted the plan, whereby they pay monthly premiums on a group accident and sick policy. As yet this plan has not been in operation long enough to justify a statement of final results, but promises to meet the greater portion of the needs at least.

Constructive criticism, on which progress relies, is always welcome from the traveling public who are quick to note mistakes and are able to discriminate between efficient and inefficient work. Realizing that sometimes criticisms of the employees are prompted by selfish motives, it is necessary to investigate carefully before taking action if the employee is to be protected and treated fairly. The patrolman must meet the criticism face to face and his job is difficult, which makes it necessary that his superior give him strong support.

In the past a number of criticisms reflecting against the maintenance employees have been traced to otuside persons impersonating highway employees. To protect the maintenance employees from the impersonator, and also to provide a means of positive identification of employees by the public, all must now wear a badge bearing a distinguishing number and displayed conspicuously on front of hat or cap. Since regular employment with the department is not attainable by all, and there is a growing pride of organization, these badges are displayed by most patrolmen with considerable pride.

Equipment.—And last but not least is the matter of equipment and the part it plays in building an organization, as well as the part it plays in maintaining roads. In purchasing equipment for the men to use, special consideration is given to equipment that can be operated with a reasonable amount of comfort and safety. Also, equipment should be designed for the purpose for which it is to be used. The patrolman has trouble and difficulties enough at best without being burdened with inadequate equipment or with equipment that is improperly designed and poorly made. Poor equipment discourages the user.

Equipment should be sturdy, reliable, simple in design, and convenient to use, easy to operate, and comfortable. The equipment should be so designed that wearing parts are readily and cheaply replaced. Equipment companies should give special consideration to the design of their equipment, to see that the failure of a certain portion does not necessitate the replacement of the entire or large expensive part, or even the entire machine.

At the beginning of our maintenance work there was on hand a large supply of government equipment, and like other states and counties, lack of funds prevented the purchasing of more suitable equipment. Consequently, government trucks, tractors and equipment were used wherever possible, although it was not strict economy to do so. As rapidly as possible the government equipment has been replaced with more suitable units, until now only a very limited number of government trucks are in use, and most of these are kept in reserve as emergency units and for heavy hauling purposes.

On gravel roads the modern motor graders are being used extensively—both the push and pull types. The operating expense of these one-man units is considerably less than the old government trucks. In many cases the saving in the operating expense plus the cost of frequent overhauling necessary on the old worn government trucks, plus the salary of the extra man required, practically offset in one season the purchase price of the more modern unit. In the beginning a large number of team patrols were also used.

When using motor graders it is necessary to supplement them at least a portion of the time with hauling units, such as the ton or two-ton truck. Very often a light truck is made available to two motor grader patrols. Where two or more motor graders operate out of a central point the patrolmen use the truck together.

Paved roads are maintained by the

gang method and 1½-ton or 2-ton speed trucks are provided for transportation of men, supplies and tools. These trucks are equipped with low mounted dump beds and underbody hoists. The large army trucks are used for the heavy hauling work. The usual number of tar kettles of 100 gal. capacity, pouring pots, hand tools, etc., are provided.

The major repairs and the concrete patching are done by a floating gang. Air compressors mounted on trucks are used for operating drills and paving breakers. One-sack concrete mixers with automatic water measuring devices are mounted for ready transportation from point to point.

It is very desirable to mark the center line of all pavements. A machine has been designed and built specially for making the center line of concrete pavements. The machine consists of a 250-gal. heating kettle mounted with burners and fuel tanks on an old truck chassis. The machine is equipped with rotating brush that sweeps ahead of the nozzle that applies the liquid asphalt. Following is a controlled sand chute that delivers the sand covering from the one cubic yard supply box on rear. The entire machine is towed behind a truck and is steered by man seated at rear of the machine, who sights forward at center line over specially adjuster sights.

On dirt roads team patrols, or wheel type tractors, are used. These tractors are provided with steel wheels and small spade lugs. On certain dirt roads motor graders with solid rubber tires are being used successfully. A motor grader equipped with 40x8 in. pneumatic tires on rear has been used for the past year with good results and with no appreciable wear of tires.

The problem of mowing shoulders, ditches and back slopes is real. Power-drawn mowers are used to considerable extent but their use is restricted. Team mowers are more satisfactory and can reach more territory but are difficult to hire when most needed. As a consequence of this condition, much hand work is necessary.

Competent men and good equipment are essential. If choice must be made, choose the competent man first. A competent and resourceful man will maintain his section even though handicapped by lack of equipment, but an incompetent man will only succeed in spoiling both equipment and road.

It pays to insist upon the men keeping their machinery clean, well oiled, greased and properly sheltered. Care of the equipment and care of the road section go hand in hand. The man who takes pride in his equipment, takes pride in his road.

It requires much labor, time and effort to keep a maintenance organization functioning, the men contented and the desired results accomplished. However, the results are well worth the effort, as there is much satisfaction in the results obtained. Often I have met a patrolman almost bursting with pride owing to the fact that some traveling man or tourist only a few minutes before had stopped and praised him for his section or complimented the organization.

In Times of Floods and Disasters.—On many occasions during floods and disasters, the men have worked long and hard hours without relief and without rest. During the past two years the state has experienced some extreme high waters, when highways were flooded, washed out and impassable. During these times the men have stuck to their jobs night and day, placing sand bags, removing drift, guarding and directing traffic, helping traffic, etc. Cases are on record where men have worked without relief 36, 48 and 60 hours. This service cannot be paid for except in the satisfaction of having done a duty well and of having the effort appreciated.

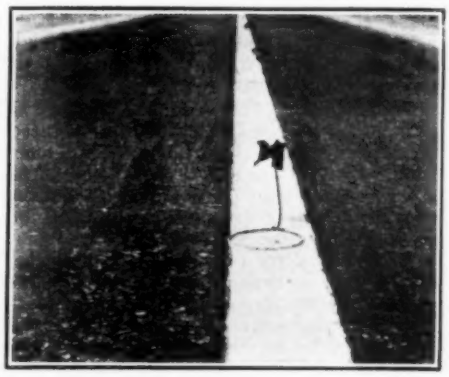
During the spring floods of 1927, when the Mississippi reached new high water mark in southeast Missouri, the value to the state of a well organized force of well trained men was very remarkably demonstrated. During the floods highway forces worked on the levees, assembled labor, transported men, troops, food, and supplies, and assisted the Red Cross and local organizations wherever needed. The men remained on the job day and night, eating food when available and sleeping on seat cushions as opportunity to do so was present. When the men could do nothing further to protect and to preserve the highways, or when the protection and rescue of lives and personal property became paramount, the organized highway forces and equipment were used where most needed until local organizations could be perfected and put into operation. As soon as local organizations began to function, the highway forces were shifted to other points as needed, or were held in waiting to act in case of any emergencies. As a result of this unusual service, many very favorable comments were received from the United States District Office, from the adjutant general, from the press, Red Cross, and others. Similar, but lesser, results are accomplished almost daily throughout the state due to loyalty, enthusiasm and good cooperation of the maintenance forces of this state. Competent men and reliable equipment are the backbone of any maintenance organization and both respond to good treatment.

Acknowledgment.—The above is a paper that was presented Jan. 22 at the 15th Annual Purdue Road School.

Method of Protecting Freshly Painted Traffic Line

Even with the use of very fast drying paint for traffic lines, it has been quite difficult to prevent vehicles from running over the freshly painted line and tracking it to other parts of the pavement.

The paint is applied with such rapidity that great lengths of line are painted in a very few minutes, and to station flagmen along the highway to direct traffic, for they would have to be numerous, would be too expensive. The placing of an occasional sign along the newly painted line helps, but it is not sufficient.



Flagging the White Stripe

A method of protecting the freshly painted traffic line, developed in District VII of the state highway system of California, that has proved very successful, is described in a recent issue of California Highways and Public Works. This method consists of the use of a great many small red flags placed at intervals of from 5 to 6 ft. along the newly painted line.

The device for supporting the small piece of red flagging consists of a piece of No. 8 iron wire bent with a loop about 6 in. in diameter for a base, with a single strand of the wire, about 6 in. long, at right angles to the plane of the base and having a small loop or kink at the end to receive the piece of flagging.

The little flags and their supports are so light and capable of being stacked, that a man can easily carry a hundred or more on his arm. He walks immediately in back of paint machine, placing the flags about 5 ft. apart along the line.

Three parallel white lines were recently painted to establish lanes along Whittier boulevard in Los Angeles County, and the work was protected with the little red flags. In several miles of lines painted, not one case of smearing of the fresh paint occurred, in spite of the fact that the traffic count during working hours along this stretch of highway averages more than 1,200 vehicles per hour.

The Construction of County Highways and Bridges

A Summary of Present Practice

By L. O. MARDEN
County Engineer, Worcester County, Massachusetts

A STUDY of the reports received from 15 county engineers, located in widely separated sections of this country indicates that a new era has arrived in the construction of county roads and bridges, in maintenance, and in the general makeup of the forces directing the work.

Practically all counties today, have established thorough cooperation with their state highway commissions (or through their own county boards), a highway system, which links up with the state highways. Provision has been made in this system, for the future expansion of the primary, and secondary trunk line county highways. Generally speaking, these county systems have been highly developed in those counties surrounding or containing large cities. Agricultural counties should make just as intensive a study of the economical location of their roads, as has been made by their wealthier neighbors. State aid is received today by most counties for primary road construction. This permits the poorer counties to place that share of the cost of primary roads paid by the state, on their secondary roads.

Control.—The state highway departments of some states exercise full supervision over the construction of primary or state aid roads. In most states, however, the county engineer has control over the construction of county highways. Those counties exercising full control over their county ways, generally have a better and more highly developed system, than those in which some distant central authority has superseded "Home Rule." The volume of work handled by some county organizations compares favorably with that done by some of our small Eastern states highway departments.

Standard Types of Construction.—The standards used for primary and secondary roads in some counties are those recommended, or furnished by law, or by the state highway department. Many counties, have however, designed their own standards.

The right-of-ways used in different counties vary from 50 to 100 ft., depending entirely on local conditions and travel.

It would appear that the following widths are being generally used for right-of-way:

Main trunk lines.....100 ft. and up
Secondary roads.....66-80 ft.
Feeder roads.....60 ft.

Grades vary from 5 per cent or less to 8 per cent. Good practice demands that the maximum grade should not be over 6 per cent. The per cent of grades today is not so important as it was before the advent of the automobile.

It is found that serious study is being made of the proper alignment for roads and that at present, the radius of curvature used varies from about 200 to 500 ft. It is suggested that where possible, the following radius of curvature should be used:

Main trunk line roads.....not less than .....1,000 ft.
Secondary roads.....not less than 600 ft.
Mountainous sections .....not less than .....250 ft.

where the amount of traffic and available funds would not warrant the heavy type of construction necessary to increase the radius.

Many counties have begun to use the "stage or progressive" system of road building on both primary and secondary highways. This consists in constructing the road on new location where necessary, to an established grade and cross section, after the new drainage structures have been built. The advantages of good alignment are thus obtained in advance of the hard pavement, which can be built at some future time.

All curves should be banked for present day speed. It is suggested that curves be banked up to 1,500 ft. radius.

Pavements.—Among the pavements now being used are:

1. Gravel surfacing treated with bitumens.
2. Penetration method, bituminous macadam.
3. Bituminous concrete.
4. Reinforced cement concrete.
5. Three-inch vitrified brick.
6. Asphalt block.
7. Sheet asphalt.

The width of the hard surface used depends upon the volume of traffic and the financial condition of the county constructing it.

In general, on main trunk lines, the width used is 24 ft. and up; on secondary roads, 20 ft. and up; on feeder roads, 18 ft. and up.

Dyer County, Tennessee reports a 12 ft. pavement in use on third class or feeder roads.

Drainage.—Standard methods are being used in determining the location, size, and grades of permanent drainage structures. Counties in prairie or coastal plain country have found it necessary to construct county ditches in order to drain the right of way. This method of drainage puts the burden of costs upon the adjacent lands benefited by these ditches. Harris County, Texas is constructing roads on a plain having a slope of 3 ft. to the mile, which makes the drainage of the roads very important. Counties in the far South are designing drainage systems based on the maximum rainfall during the rainy season. Pinellas County, Florida, obtained through its Board of County Commissioners, an aerial survey and map of the entire county compiled in the form of an atlas and to a scale of 1 in. to 800 ft. This map has proven of great value in their drainage work alone, and has facilitated the work to a great extent, as topographical data was immediately available in all preliminary work.

Culverts are being constructed of corrugated metal, cast iron, reinforced concrete pipe, and reinforced concrete.

Reinforced concrete appears to be favored for most bridges, although some of the poorer counties still find it necessary to construct wooden structures. Steel is, of course, being used on most of the larger bridges.

Bridge plans are being furnished in many cases by the state highway departments. It is suggested that all bridges should be built with a clear distance from curb to curb equal to the width of pavement plus the width of the shoulders. It is realized today that the artistic appearance of a bridge should be given considerable attention when possible and practical. Most counties are constructing bridges having a minimum capacity of 15 tons.

Local Materials.—In some sections the only road material available is the earth necessary to form the grade, and gravel to form the finished surface. Quarries are being operated when a rock suitable for pavements or concrete is available. In Florida, native soft lime rock is being extensively used, with very satisfactory results, for base material. Oyster shells and marl are used in some coastal regions. In New England the broken stone base is generally obtained from the old stone walls forming the location lines of the highway or from old rock piles in the fields.

Careful field examination is generally being made of all materials to be used on roads or bridges. Scentific tests are

made in well equipped laboratories of materials for concrete pavements, bridges or the mix for sand-clay roads, etc.

Low Cost Roads.—The cost of the low type road varies in accordance with the type of country in which the road is to be built. It also varies with the amount of scientific study made of how to use to the best advantage the materials at hand to construct a surface of excellent quality, with a small fund and cover a maximum area of country at the same time. In 1924 91 per cent of the total highway mileage, or 2,723,-195 miles of the entire country were under the control of the counties and townships. Only 339,558 miles, or 12 per cent of the above total mileage, were surfaced. It can be seen that it is of extreme importance that the remainder of this mileage be surfaced in the best possible manner at the smallest possible cost.

In the plains country, the grading is done with an elevating grader and caterpillar tractor, dump wagons or trucks being used to move the dirt from cuts to fills. Dirt roads can be built in this manner for about $1,000 per mile. The gravel surface can be added to this type of dirt road for about $1,000 to $1,600 per mile, depending upon the width of surface and the distance gravel must be hauled.

Gravel roads in New England having a stone base and 18 ft. gravel surface cost about $15,000 per mile. Most counties at the present time, are surfacing their low cost roads with liquid bitumens or constructing a penetration type bituminous macadam pavement on the old base. The "cold or hot mix-in-place" type of surfacing is being used by a great many counties. Pinellas County, Florida, has been constructing some highways of oyster shells or local marl. It is, of course, realized that proper drainage is essential in the construction of a low cost road.

Grade Crossings.—Some progress is being made in the elimination of grade crossings. All county engineers should make an intensive campaign for the economic elimination of grade crossings.

It is suggested that more study should be made regarding intersections of roads so that sufficient right-of-way can be taken, in order that gas stations and other business buildings can not be constructed close to the travelled way and obstruct the view of approaching vehicles from the cross road. Special wide approaches are being made in some counties at dangerous intersections.

Standard direction and warning signs are in general use throughout the country.

Method of Handling Bids.—Some progress is evident in the method of placing information before contractors, as to details of construction, source and supply of materials, railway and other transportation facilities and labor conditions, before the proposal is given serious consideration. Information of this nature given the contractor will lower unit prices and assist in more intelligent bidding.

Conclusions.—Highway systems have been established in practically all counties.

Control of the construction of county highways should be in the hands of the county engineer.

Standards and specifications should be originated by the County Highway Officials' Division for use on county construction.

Careful consideration should be given the construction of highways by the stage or progressive system of road building.

It is suggested that a committee be formed to investigate economic possibilities of the different types of pavements and design new standards where possible.

Most counties are providing for the proper drainage of roads. Road drainage should be given the utmost consideration.

Scientific study is being made of the available local materials for road construction.

The low cost type of road merits more study on the part of the county officials throughout this country, for by its successful use the poorer and more backward counties can be "pulled out of the mud."

Grade crossings should be eliminated wherever economically possible.

Better approaches should be made at trunk line crossings.

Better unit prices can be obtained on contracts by placing more information before contractors before the proposal is made.

County engineers should give the technical side of their office more time, so that any interesting or new methods developed by them can be placed before this division in the form of a well written paper.

Acknowledgment. — The above is taken from the committee report on County Road Construction presented Jan. 17 at the 26th Annual Convention of the American Road Builders Association.

Caliche Base Courses and Surface

By A. J. WISE
County Engineer, Harris County, Texas

The principal factor of economy in road building is that of the utilization of local materials to the best advantage.

A local material found in many of the southwestern and western counties of Texas is caliche. Caliche has made possible the building of many miles of road, that, but for its presence, could not have been surfaced except at prohibitive cost. Caliche is of a mixture of calcareous dust and quartz sand sometimes mixed with gravel or small stones. There is a wide variation as to quality. Some, after the surface crust hardened by the weather, has been blasted off can be loosened up by plow. This material when put on the road packs well and hardens into almost a stone formation after exposure to the weather. Other pits of caliche are too hard to plow and powder must be used in the mining. Under traffic or the roller on the road, however, the lumps break up and mold together, forming a dense compact surface.

The construction of caliche roads, usually is very similar to the construction of other types of light class surfacing, such as gravel, shell, etc. However, in most cases where the average rainfall is very light, best results have been obtained by puddling the caliche. This can be done either in the pit before the caliche is hauled on the road or by sprinkling with water after the material has been spread upon the subgrade. In case puddling is done in the material pit, the caliche should at once be hauled on to the road, spread by means of hoes, rakes or shovels, shaped and rolled before it has dried out. In case puddling is to be done after the caliche has been placed and spread upon the subgrade, the surface should be thoroughly harrowed, plowed or otherwise opened up, during the process of sprinkling, in order that the proper puddling of the caliche be insured.

The greatest objection to caliche surfaces has been dust and glare, but in the last few years the Texas Highway Department and some Texas counties have topped these caliche roads with a natural limestone rock asphalt treatment about 1 in. thick, placed cold, which has proven very satisfactory. A well constructed caliche base also serves as a splendid foundation for the application of a one or two-course inverted penetration surface treatment.

As previously stated, the quality of caliche found in different localities and even in the same locality varies considerably. Roads of the best quality of caliche are as good, in the writer's opinion, as those built with limestone or gravel. There are others that are only slightly better than a mud shell or sand clay surface, but as this material is found conveniently along the road its use is economical until traffic increases to such an extent as would require concrete or other high type pavement to carry it.

Acknowledgment.—The foregoing is taken from the Committee Report on County Road Construction presented Jan. 17 at the 26th Annual Convention of the American Road Builders' Association.

Depreciation of Equipment Used in Highway Construction and Maintenance

A Committee Report Presented at Cleveland's Convention, A. R. B. A.

By W. A. VAN DUZER

Assistant Chief Engineer, Pennsylvania Department of Highways; Chairman American Road Builders Association Committee on Depreciation of Equipment

MODERN road construction is a product of the last quarter of a century. Road types and methods have changed materially in that time. In the early days, before the advent of rigid type pavement, the equipment used upon a construction project represented only a small portion of the cost of the work. After the war the labor shortage became acute and the majority of construction was rigid type pavement. With the increased cost of work, equipment was invented to reduce the amount of labor and increase production.

Why Committee Was Established.—Many contractors did not realize that replacement of equipment must be carried by the job, or the units of work performed, and found that their total assets at the end of a season or two consisted of equipment, the greater part of which was obsolete. The directors of the American Road Builders' Association, realizing the situation which had previously existed, had three principles in mind when they appointed a committee on depreciation of contractors' equipment.

First—To have the information so that fair rental rates might be set up by the contractor for his equipment for use in connection with the cost-plus-a fee contracts; such rental rates, however, not to include profit. If a profit on the equipment is to be added, an adjustment in the rate will be necessary. Also, that the contractor might set up a rental rate to use on contract work so that sufficient money would be set aside to pay for the depreciation, interest, insurance and operation of the equipment.

Second—To give public officials information on the value of machines so that they may evaluate the list of plant submitted with the bidder's questionnaire. Also, to give public officials information for setting up rental rates for equipment owned by the states or their sub-divisions, used principally on maintenance work, so that the equipment charges will be represented in the cost of the work.

Third—To provide information for bankers and others who have credit transactions with the construction companies.

In addition to the value of the depreciation schedule to contractors and road officials, there are five branches of the Federal Government now working on the subject of depreciation; they are, the Interstate Commerce Commission, Internal Revenue Department, Federal Power Commission, Department of Commerce and the Tariff Commission.

When a Machine Is Obsolete.—An aggregate of improvements over a period of time will make any machine obsolete. This is the particular type of depreciation which is being studied by the Interstate Commerce Commission.

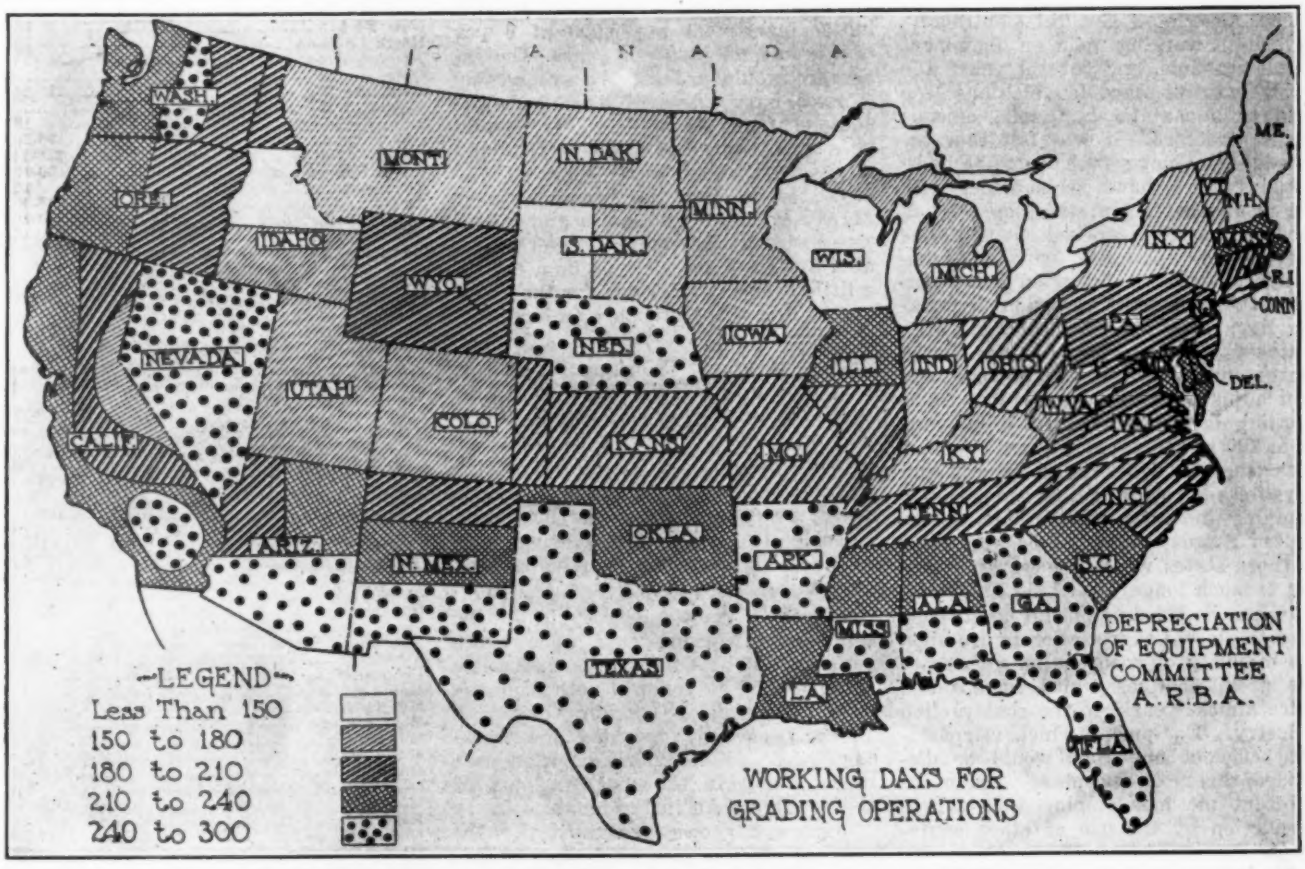


Fig. 1—Map Showing Number Working Days for Grading Operation in the Various States

Gradual depreciation is really obsolescence.

It has been very difficult to get accurate information on the subject of depreciation on account of the insufficiency of records and it is hard to tell the difference between depreciation and obsolescence. The sub-obsolescence due to invention is something nobody can tell about for some time. There will be changes made which are bound to be revolutionary. We, therefore, must separate the studies between gradual obsolescence, which is going on continuously, and sub-obsolescence, which is changing from one type of equipment to a more suitable one.

Essentials in Study of Depreciation.—The Bureau of Internal Revenue considers two things to be essential in the study of depreciation:

First—A statement of the useful lives of the depreciable assets of an industry by items or classes of similar items, preferably departmentalized according to the different processes employed, services rendered, or products made by the industry. Such a schedule affords the only possible basis of comparison between the diverse methods for depreciation accounting, and gives the fundamental information required for the determination of essentially similar depreciation rates irrespective of the methods employed.

Second—A statement of the principles and methods of depreciation accounting best suited to the business conditions of the industry to which the results of the study will apply.

The Associated General Contractors have been working upon an equipment rental schedule, and several years ago put a tentative schedule which has been used to advantage by public officials and contractors. It was felt that the schedule was not complete and so additional studies have been made, with the result that a tentative depreciation schedule has been worked out and gone over by the committe, with a recommendation that it be given consideration. Of course, the variation in working days even in different parts of a state—to say nothing of the United States—makes it necessary to make certain adjustments in rental rates. The working days in the United States vary from 120 to 240 days; it is evident that with such a wide range of working days for road construction, a rental rate applying in the northern part of the United States would not be applicable to those states where the working season is much longer.

It has been very difficult up to this time to place a depreciation figure upon the majority of road equipment due to the great changes which have taken place almost yearly in the construction industry. Equipment which is considered efficient one year would be discarded the next season on account of different methods employed on larger production by the use of other equipment.

We believe the industry is sufficiently established at this time so that sub-obsolescence due to the inadequacy of equipment will be reduced to a minimum. This factor has not been considered in setting up the proposed rental schedule.

Three Methods of Figuring Depreciation.—The committee of the Associated General Contractors agree on three methods of depreciation:

1. The unit of time basis—charge off so much depreciation for each hour, day or month used.
2. The unit of work basis—charge off depreciation according to the work done.
3. Contractor's equipment or job method.

In applying the rental schedule, the question arises whether the rental rates for 120 working days a season should be twice as much as the rental rates for the 240 day season. Unquestionably equipment depreciates even if not used, but there is a question whether it depreciates in direct proportion; that is, if the equipment is not working a certain number of days a year, if it depreciates as fast as if it were working. It would seem to us that such would be the case, and that repairs to the equipment would be the only addition made and spread over the total days worked. An arbitrary figure would have to be set up for this item and probably adjustments made each year.

If a piece of equipment, say a tractor, cost originally $5,000 and is depreciated at the rate of 20 per cent a year, which would be $1,000, the interest on the initial investment of $5,000 at 6 per cent would be $300 per year. The insurance would probably be around $50 a year, irrespective of how much the equipment is operated. There would be a fixed charge of $1,350 a year and if the equipment were operated 120 days, the cost per day would be over $11.00, exclusive of repairs and operation costs. If the equipment were operated 240 days, there would be a cost of a little over $5.50 per day for the above named items, but probably an increased cost in repairs.

The Average Working Year.—It would seem to be fair, therefore, to set up the average year's life for the average equipment, giving a straight-line depreciation.

Table I shows the working days upon which grading can be done by states.

Table II shows the working time upon which pavement can be laid by states.

Figure 1 shows geographically the number of working days upon which grading can be done. It is impossible to zone this, as you will note from the wide variation in working days, although generally speaking the working days, as may be expected, are much longer in the southern part of the country than in the north.

Figure 2 shows geographically the number of days pavements can be laid in the United States.

The accompanying table is a schedule of equipment depreciation by percentages. Unquestionably there will be changes in this schedule from time to time, but it is felt by your committee that this will be a working basis on about 250 pieces of equipment, the most of which are used in road construction.

It is the recommendation of the committee that a Committee on Depreciation of Equipment be made a permanent part of the American Road Builders' organization and that this committee work with a similar committee of the Associated General Contractors.

Table I, Grading.—Working days per year exclusive of Sundays, holidays and bad weather.

State	Days
Alabama	240
Arizona	200-300
Arkansas	300
California	155-300
Colorado	*
Connecticut	200-240
Delaware	220
Florida	240
Georgia	300
Idaho	120-200
Illinois	180-240
Indiana	160-175
Iowa	175
Kansas	200
Kentucky	175
Louisiana	225
Maine	140
Maryland	180-240
Massachusetts	225
Michigan	180
Minnesota	150
Mississippi	240
Missouri	*
Montana	*
Nebraska	250
Nevada	240-300
New Hampshire	140
New Jersey	.....
New Mexico	*
New York	160
North Carolina	200
North Dakota	150
Ohio	.....
Oklahoma	225-240
Oregon	.....
Pennsylvania	190
Rhode Island	190-200
South Carolina	210-240
South Dakota	130-165
Tennessee	190
Texas	240-300
Utah	170-180
Vermont	155
Virginia	180-210
Washington	*
West Virginia	*
Wisconsin	140-150
Wyoming	200

*Data not received.

Table II, Paving.—Working days per year exclusive of Sundays, holidays and bad weather.

State	Days
Alabama	240-300
Arizona	200-300
Arkansas	300
California	120-300
Colorado	*
Connecticut	125-155
Delaware	160
Florida	240-up
Georgia	300
Idaho	80-120
Illinois	120-135
Indiana	120-140
Iowa	125
Kansas	140
Kentucky	100
Louisiana	225
Maine	110
Maryland	140
Massachusetts	150
Michigan	130
Minnesota	100
Mississippi	160
Missouri	*
Montana	100-120
Nebraska	225
Nevada	150-175
New Hampshire	100
New Jersey	.....
New Mexico	*

State	Days
New York	150
North Carolina	200
North Dakota	180
Ohio	*
Oklahoma	225-240
Oregon	*
Pennsylvania	120-140
Rhode Island	140-150
South Carolina	180-240
South Dakota	110-140
Tennessee	175
Texas	180-240
Utah	170-180
Vermont	115
Virginia	150-180
Washington	*
West Virginia	160-200
Wisconsin	110
Wyoming	140-160

*Data not received.

Associated General Contractors of America.—Schedule of equipment depreciation.

Items of Equipment	Average Useful Life Years	Days Work	Annual Depreciation Pct.
Automobiles, Light	2	460	50
Automobiles, medium	3	690	33
Automobiles, heavy, high grade	4	920	25
Backfillers, light	3	380	33
Backfillers, medium	4	505	25
Backfillers, heavy	5	630	20
Ballast spreader cars	10	300	10
Barbenders	3	530	33
Barcutters	3	530	33
Batchboxes	3	350	33
Batch Inundators	3	305	33
Batch Measuring Devices	3	350	33
Batcher plants, all steel demountable	4	470	25
Batcher plants, steel, fr. wood bin	4	470	25
Batcher plants, wood frame and wood bin	2	235	50
Bin frames, steel	5	585	20
Bins only, steel	5	585	20
Bins only, wood	2	235	50
Blacksmith shop outfits	4	770	25
Boilers, locomotive	7	700	14
Boilers, upright	7	700	14
Buckets, cable way	4	410	25
Buckets, concrete	3	310	33
Buckets, clam-shell	4	445	25
Buckets, drag-line	4	430	25
Buckets, orange peel	4	400	25
Buildings, job office, steel standard	3	900	33
Bulldozers, for tractor	2	200	50
Bunkers, stone portable, with screen	3	345	33
Cableways, cable only	3	395	33
Cableway Carriages	5	660	20
Cableway towers, steel	4	530	25
Cableway towers, wood	2	265	50
Cars, batch box, steel	4	470	25
Cars, boarding and tool	7	1260	14
Cars, concrete	4	410	25
Cars, dump, steel	7	820	14
Cars, dump, wood	5	585	20
Cars, flat, steel	8	1150	12½
Cars, flat, wood	6	865	17
Cars, hopper, steel	9	800	11
Carts, concrete	3	250	33
Channelers, rock machine	4	350	25
Concrete Machines, pneumatic	4	280	25
Compressors, motor truck unit	5	570	20
Compressors, portable, electric	6	630	17
Compressors, portable, gas	4	420	25
Compressors, portable, steam	6	630	17
Concrete Spouting Equipment			
Concrete buckets	3	310	33
Hoppers	3	310	33
Spouts and chutes	2	210	50
Towers, steel boom and counterweight	5	560	20
Tower spouting plant complete	4	415	25
Conveyors, elevating, belt, portable	3	250	33
Conveyors, elevating, belt, stationary	4	350	25
Cranes, motor truck, mounted	4	430	25
Cranes, crawler, electric light	5	540	20
Cranes, crawler, electric, medium	6	650	17
Cranes, crawler, electric heavy	8	865	12½
Cranes, crawler, gas, light	4	480	25
Cranes, crawler, gas, medium	5	600	20
Cranes, crawler, gas, heavy	6	720	17
Cranes, crawler, steam, light	5	600	20
Cranes, crawler, steam, medium	6	720	17
Cranes, crawler, steam, heavy	8	960	12½
Cranes, locomotive, gas	7	850	14
Cranes, locomotive, steam	10	1240	10
Crushers, rock, portable	4	460	25
Crushers, rock, stationary	6	690	17
Cutting and welding outfits, portable	4	320	25
Derrick cars, bridge, builders, complete	10	690	10
Derrick crabs, hand	6	720	17
Derrick crabs, power	4	480	25
Derricks, guy, steel	8	1320	12½
Derricks, guy, wood	4	660	25
Derricks, hand, circle swing	4	480	25
Derricks, stiff leg, steel	8	1320	12½
Derricks, stiff leg, wood	4	660	25
Drag lines, electric, light	5	540	20
Drag lines, electric, medium	6	650	17
Drag lines, electric, heavy	8	865	12½
Drag Lines, gas, light	4	480	25
Drag lines, gas, medium	5	600	20
Drag lines, gas, heavy	6	720	17
Drag lines, steam, light	5	600	20
Drag lines, steam, medium	6	720	17
Drag lines, steam, heavy	8	960	12½
Drills, electric, rock	3	320	33
Drills air tripod	4	400	25
Drills, air, drifter	3	315	33
Drills, jack hammer	3	330	33
Drills, tunnel carriage	5	300	20
Drills, well, traction	6	360	17
Drill sharpeners, pneumatic	5	660	20
Electric tools			
Boring machines	3	360	33
Drills, hand	3	360	33
Grinders	3	360	33
Hammers	2	240	50
Saws, hand	2	240	50
Elevators, buckets, stationary	4	460	25
Elevators, cage, steel tower	5	580	20
Engines, only, gas	5	510	20
Engines, only, oil	5	850	20
Engines, only, steam	10	920	10
Excavators, cableway, complete except power	3	345	33
Finishing machines	3	350	33
Floats, bridge, steel	4	470	25
Forms, steel, curb and gutter	3	420	33
Forms, steel road	3	350	33
Forms, steel, wall	4	300	25
Forms steel, tunnel	2	250	50
Gin poles, steel	5	825	20
Graders, blade, road, light	2	230	50
Graders, blade, road, medium	3	350	33
Graders, blade, road, heavy	5	600	20
Graders, blade, road, power, light	2	230	50

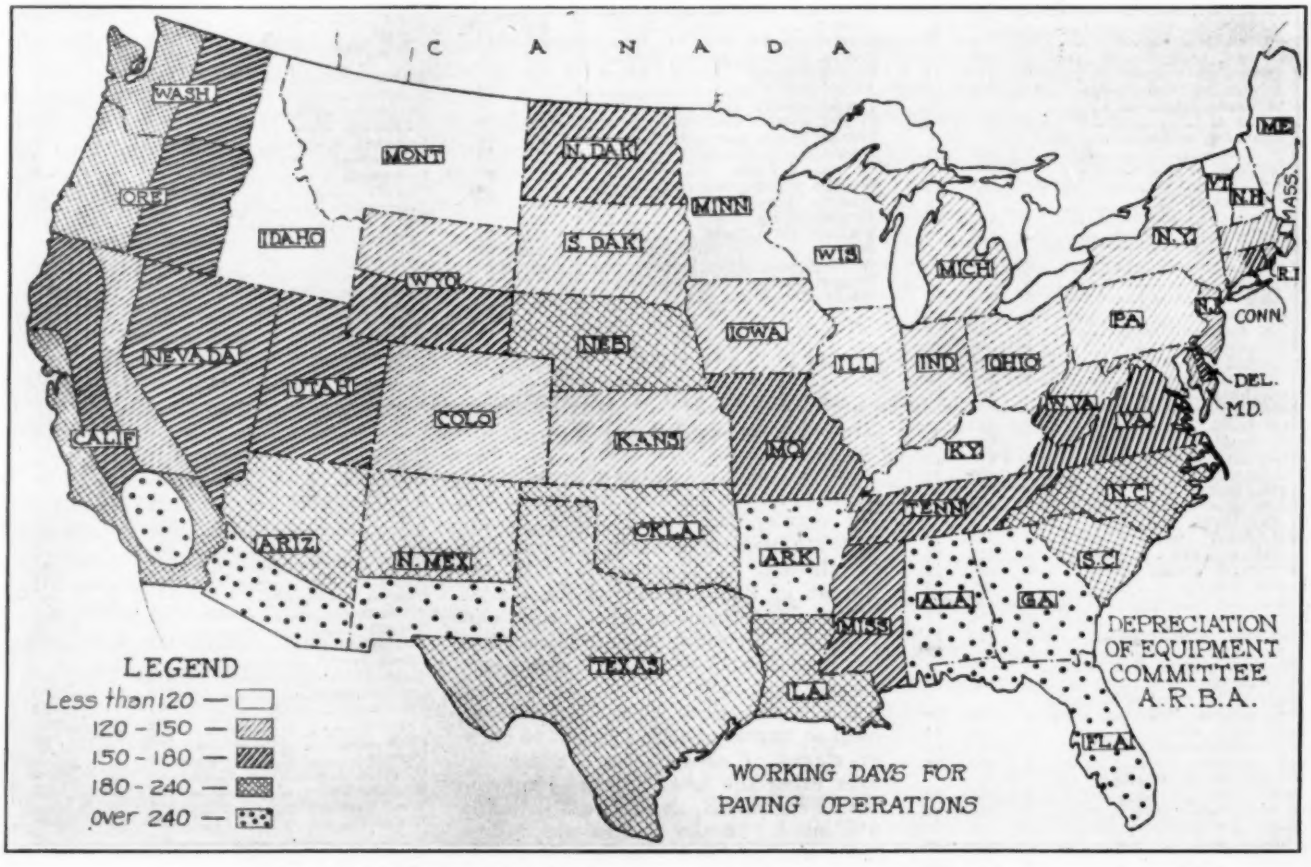


Fig. 2.—Map Showing Number of Days Pavement Can Be Laid in the Various States

Items of Equipment	Useful Life Days Average Years	Work	Depreciation Annual Pct.
Graders, blade, road, power, medium	3	350	33
Graders, blade, road, power heavy	4	500	25
Graders, elevating	4	550	25
Graders, form (subgrader planers)	3	360	33
Gravel washers (See washers)			
Hammers, air (See pneumatic tools)			
Hammers, pile (See pile hammer			
Hoisting Units, chain	5	825	20
Hoisting Units, drum, electric	7	900	14
Hoisting Units, drum, gas	5	650	20
Hoisting Units, steam with boiler	8	1020	12½
Hoisting Units, post, electric	4	660	25
Hoists, only, drum, no power	10	1650	10
Hoist slews, steam	10	1650	10
Hoist slews, electric	5	825	20
Hydraulic giants	7	755	14
Inundators (See batch inundators)			
Jacks, hydraulic	6	990	17
Jacks, screw	5	880	20
Lead melting furnaces	5	540	20
Loaders, bucket, stationary	6	460	17
Loaders, bucket, crawler	4	350	25
Loaders, bucket, portable	5	300	20
Locomotives, battery	4	500	25
Locomotives, gasoline, light	4	470	25
Locomotives, gasoline, medium	5	585	20
Locomotives, gasoline, heavy	6	700	17
Locomotives, steam, industrial, light	7	770	14
Locomotives, steam, industrial, medium	8	880	12½
Locomotives, steam, industrial, heavy	9	990	11
Locomotives, steam, railroad type	12	1225	8
Mixers, concrete, A. G. C. Std.			
Building, electric	4	500	25
Building, gas, light	2	250	50
Building, gas, medium	3	375	33
Building, gas, heavy	4	500	25
Building, steam	5	550	20
Paving, gas (21-E obsolete)	4	450	25
Paving, steam (21-E size obsolete)	4	500	25
Truck mounted units	3	360	33
Mixers, mortar, portable	3	360	33
Motors, electric, small	4	480	25
Motors, electric, medium	5	600	20
Motors, electric, large	6	720	17
Mowers, right of way	3	350	33
Oilers, road, tank wagon, steel	6	700	17
Pile drivers, steam outfit on skids	6	600	17
Pile drivers, railroad outfits	10	650	10
Pile hammers, steam or air, light	3	270	33
Pile hammers, steam or air, medium	5	450	20
Pile hammers, steam or air, heavy	7	560	14
Pipe, galvanized	4	460	25
Pipe, black	4	460	25
Plows, furrow or rooter	3	340	33
Pneumatic Tools			
Backfill tampers	3	300	33
Borers, wood	3	300	33
Calking and chip hammers	3	300	33
Clay diggers	3	300	33
Drills, jack hammer	3	330	33
Holders-on	4	400	25
Pavement breakers	3	300	33
Riveters	3	300	33
Saws, hand	3	300	33
Pumping Units, Portable			
Centrifugal, electric	4	470	25
Centrifugal, gas	3	350	33
Diaphragm, electric	4	470	25
Diaphragm, gas	3	350	33
Piston, electric	4	470	25
Piston, gas	3	350	33
Pumping Units, Stationary			
Centrifugal, electric	5	585	20
Centrifugal, gas	4	470	25
Centrifugal, steam	5	585	20
Piston, electric	5	585	20
Piston, gas	4	470	25
Piston, steam	5	585	20
Pumps only, centrifugal	6	600	17
Pumps only, impulse	8	720	12½
Pumps only, piston	6	650	17
Rails, steel	8	1060	12½
Riveters (See pneumatic tools)			
Rollers, concrete finishing, steel	5	585	20
Rollers, road, gas	7	800	14
Rollers, road, steam	9	1100	11
Rooter Graders, wheel	4	470	25
Saws and wood workers, steel frame	5	700	20
Saws and wood workers, wood	3	420	33
Scarafier attachments	2	235	50
Scarafiers, drag, all steel	3	350	33
Scarafiers, grader type	3	350	33
Scarafiers, block, steerable	4	470	25
Scrapers, fresno	2	260	50
Scrapers, maney	3	390	33
Scrapers, morman	2	260	50
Scrapers, rotary	2	260	50
Scrapers, slip	1	150	100
Scrapers, wheel	3	360	33
Screens and bunkers	3	350	33
Screens only	3	345	33
Shores, adjustable	3	480	33
Shovels, crawler or wheel, electric, light	5	540	20
Shovels, crawler or wheel, electric, medium	6	650	17
Shovels, crawler or wheel, electric, heavy	8	865	12½
Shovels, crawler or wheel, gas, light	4	480	25
Shovels, crawler or wheel, gas, medium	5	600	20
Shovels, crawler or wheel, gas, heavy	6	720	17
Shovels, crawler or wheel, steam, light	5	600	20
Shovels, crawler or wheel, steam, medium	6	720	17
Shovels, crawler or wheel, steam, heavy	8	960	12½
Shovels, railroad, steam	9	1080	11
Shovels, tunnel	3	300	33
Stone spreaders, hopper wagon	4	320	25
Stone spreaders, steel box	4	320	25
Subgrade (See graders) planers.			
Switches, portable	3	360	33
Switches, stationary	4	480	25
Tool carts, steel	4	700	25
Track, industrial, portable	4	600	25
Tractors, very light	2	240	50
Tractors, light	3	350	33
Tractors, medium	4	470	25
Tractors, heavy	5	600	20
Trailers, dump, steel	5	540	20
Trailers, dump, wood	4	430	25
Trailers, platform, wood	4	430	25
Trailers, drop platform, heavy duty	5	420	20
Towers (See elevators and concrete equipment)			
Trenching machines, gas, light	3	300	33
Trenching machines, gas, medium	5	500	20
Trenching machines, gas, heavy	7	700	14
Trenching machines, steam, light	5	500	20
Trenching machines, steam, medium	6	600	17
Trenching machines, steam, heavy	8	800	12½
Trucks, general purpose, light	2	375	50
Trucks, general purpose, medium	3	560	33
Trucks, general purpose, heavy, high grade	4	750	25
Trucks, dump, light	2	235	50
Trucks, dump, medium	3	350	33
Trucks, dump, heavy, high grade	4	470	25
Turntables, industrial rwy.	4	470	25
Turntables, truck	3	350	33
Wagons, dump, steel	5	600	20
Wagons, dump, wood	4	480	25
Wagons, farm, heavy	4	480	25
Wagons, farm, light	3	360	33
Wagons, tank or sprinkler, steel	5	600	20
Wagons, tank or sprinkler, wood	3	330	33
Wagon loaders (See loaders)			
Washers, gravel	3	345	33

Nearly 10,000 Miles of Federal-Aid Highways Improved Last Year

A total of 9,754 miles of Federal-aid highways were improved in the calendar year ending Dec. 31, 1928, by the 48 State highway departments and that of Hawaii, in cooperation with the Bureau of Public Roads of the United States Department of Agriculture. Of that total, according to figures compiled by the bureau, 7,625 miles had not previously been improved with Federal aid, while 2,128 miles which had already been so improved were brought to higher stages of construction. These figures bring the total mileage improved with Federal aid, as of Dec. 31, to 76,075 miles. In the Federal-aid system are a total of 188,017 miles.

At the end of December, 9,216 miles of Federal-aid roads were under construction and 1,597 miles were approved for construction.

Of the mileage not previously improved with Federal aid, South Dakota, with 578 miles, heads the list of states. North Dakota, with 490 miles, ranks second; Nebraska, with 483 miles, is third; Kansas, with 423 miles, is fourth; New York, with 416 miles, is fifth; Texas, with 361 miles, is sixth; Montana, with 298 miles, is seventh; and Alabama, with 276 miles, ranks eighth.

With the exception of New York and Texas, the large mileages of the above states are, for the most part, of the lower types of road construction.

In mileage already improved with Federal aid and brought to higher types of construction, North Dakota, with 385 miles, heads the list of states. Nebraska, with 278 miles, ranks second; Texas, with 262 miles, is third; South Dakota, with 252 miles, is fourth; Minnesota, with 118 miles, is fifth; Iowa, with 106 miles, is sixth; South Carolina, with 92 miles, is seventh; Wyoming, with 78 miles, is eighth; Alabama, with 58 miles, is ninth; and Georgia with 57 miles, ranks tenth.

The 9,763 miles improved in 1928 is 1,478 miles or 18 per cent more than the 8,285 miles improved in 1927.

Individual State Mileages Improved for the Calendar Year Are as Follows

State	Mileage not previously improved with Federal aid	Mileage brought to higher stages of construction
Alabama	276	58
Arizona	35	2
Arkansas	123	.....
California	105	9
Colorado	70	20
Connecticut	39	.....
Delaware	16	4
Florida	86	.....
Georgia	71	57
Idaho	94	54
Illinois	116	.....
Indiana	208	.....
Iowa	216	107
Kansas	423	14
Kentucky	186	22
Louisiana	39	.....
Maine	41	.....
Maryland	60	.....
Massachusetts	81	.....
Michigan	149	.....
Minnesota	223	118
Mississippi	181	15
Missouri	166	28
Montana	298	12
Nebraska	484	278
Nevada	54	53
New Hampshire	28	.....
New Jersey	37	.....
New Mexico	147	.....
New York	416	9
North Carolina	109	47
North Dakota	490	386
Ohio	184	12
Oklahoma	255	11
Oregon	50	18
Pennsylvania	184	.....
Rhode Island	23	.....
South Carolina	114	92
South Dakota	578	252
Tennessee	72	20
Texas	362	262
Utah	102	33
Vermont	43	.....
Virginia	69	6
Washington	79	5
West Virginia	117	.....
Wisconsin	106	48
Wyoming	198	78
Hawaii	22	.....
Totals	7,625	2,128

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Testing the Truth of a Scientific Theory

The only test of the truth of a scientific theory is its agreement with facts. But this raises a question as to what and how many facts a theory must explain before it can be said to be established. Even the crudest of theories shows some accord with some fact or facts, but it is worthy of note that a false theory rarely explains any facts that it was not invented to explain. Indeed, the failure of a theory to explain more than it was originally designed to explain makes it probable that the theory is wrong.

On the other hand a true theory is astonishingly fruitful not only in its capacity of explaining facts not contemplated by its originator, but in its use in discovering new facts. Contrast, for example, Newton's theory of gravitation and the Cartesian theory of vortexes. Both theories were used to explain why planets travel around the sun; but whereas Newton's theory has been successfully applied to solve numberless other astronomical problems, the Cartesian theory has fallen flat at every effort to travel beyond its original bounds.

Another test of a new theory is its ready concordance with established old theories. True theories have a way of supporting one another. Since all nature is kin, there must be a kinship between true theories. Therefore any theory that stands aloof from other theories, and resists all efforts to bring it into the family of scientific theories, should be regarded with suspicion.

The La Place "nebular hypothesis" of the origin of our solar system failed to explain more than the few facts that it was designed to explain, it did not lead to any new discoveries, and it never found kinship with any other established theory. Finally one of its primary assumptions was seen to be very questionable as to its mechanical possibility, namely the assumption that in a rotating nebula rings of material would be "left behind" as the nebulous spheroid shrank to smaller diameter.

A few years ago Chamberlain and Moulton advanced the hypothesis that a passing star had disrupted our sun and that the planets were formed from the solar matter thus scattered. In a book just published by the University of Chicago Press, Prof. Chamberlain expounds this hypothesis at length, and adds thereto the hypothesis that the comets were not caused by this ancient disruption of the sun but were subsequently ejected by the internal forces of the sun. This hypothesis of comet genesis bears a resemblance to the sunspot theory of planet genesis first published by the editor in Engineering and Contracting, July, 1926, and more recently in October, 1928.

Prof. Chamberlain's hypothesis of planet genesis explains none of the following facts: (1) The geometric series of planetary periods of revolution; (2) the same sort of series as to the moons; (3) the fact that the diameters of Mercury, Earth and Saturn are closely proportional to their distances from the sun; (4) a similarly progressive increase in the diameters of certain moons as their distances from the planet increases; (5) the fact that our moon almost exactly blots out the sun at full eclipse; (6) the increase in the axial rotation of planets as their distance from the sun increases; (7) the gaps between the clusters of asteroids at points where their mean motion is commensurate with that of Jupiter.

On the other hand each of these astronomical facts is quantitatively accounted for by the sunspot theory of planet genesis.

In addition to its failure to explain many important features of our solar system, Prof. Chamberlain's hypothesis is just as vulnerable as that of La Place, as to one of its basic premises. If a passing star had gravitative power sufficient to pull part of the sun away from the sun, what caused that star to release any of the matter thus pulled away and leave it behind as orbital matter from which the planets grew? The more this question is pondered, the greater the difficulty in answering it. Indeed it seems necessary to add the further hypothesis that the passing star suddenly blew up, just after it had disrupted the sun, and so was unable to carry away the solar material.

So greatly do Jupiter and its moons resemble the sun and its planets that Galileo was convinced by this fact alone that Copernicus was correct in his theory that the planets revolve about the sun. Galileo rightly saw in Jupiter and its satellites a miniature solar system, and, as Whewell says, "he showed, by the evidence of the eyes, how inadequate were the conceptions, and how erroneous the doctrines of the ancients, respecting the constitution of the universe." If this be true, well may we ask what other passing star disrupted Jupiter to form another solar system in miniature? And the same question rises as to every one of the planets that has one or more moons. Prof. Chamberlain summons only one star "from the vasty deep," yet his hypothesis really calls for at least six more such catastrophic visitants, one for each of the planets that has begotten satellites.

Speaking of the La Place nebular hypothesis 83 years ago Sir John Herschel, the great English astronomer, said: "But if it is to be regarded as a demonstrated truth, or as receiving the smallest support from any observed numerical relations which actually hold good among the elements of the planetary orbits, I beg leave to demur." And on the very same basis Herschel would have to demur as to the Chamberlain hypothesis. Hypotheses such as these must not only be plausible as to their premises but probable as to the inferences that can be drawn from the hypotheses, if they are to sur-

vive. And in weighing the degree of probability of the truth of an hypothesis, nothing is more convincing than its quantitive concordance with facts of several kinds over a wide range of variation. When some of these quantitative agreements were not known at the time the theory was first framed, the later discovery of such agreements amounts to proof conclusive of the truth of the theory. It is this sort of test that makes exact verification of a predicted eclipse carry conviction of the truth of the theories on which the prediction was based. Similarly when fact after fact is seen to agree with an hypothesis, without aid from new hypotheses, the hypothesis beocmes established as probably true, the degree of probability rising, not merely in proportion to the number of such agreements but in much greater proportion. In fact one exact quantitative agrement of theory with fact, where several variables exist, may alone raise the probability of its truth to practical certainty.

Some Erroneous Geometrical Definitions

If the Euclidian definitions of point and line are correct, then men are capable of reasoning about things that can not be seen or otherwise sensed. A point is defined as having position without magnitude, and a line is defined as having length without breadth or width. As thus defined neither a point nor a line could be seen. But, it is replied, they can be conceived, and pure geometry deals primarily with ideal conceptions that relate to space.

It may be well to ask what is meant by the word "conceive." To conceive a thing that has once been seen is to revive the vision, to "re-see in the mind's eye." The geometrician is helpless without drawings, and his whole science rests upon visualization. Yet at the very start he informs the student that points and lines have certain dimensions that are non-existent and therefore invisible. Surely a curious start for a science that is helpless without its pictures.

A pictorial conception may consist of new groupings and arrangements, but there is never anything new about its elementary units or parts. Hence, it is an illusion to believe that pictorial conception of unseeable units is possible. A point, as defined by geometers, is an unseeable unit. We insist, therefore, that it is not conceivable as defined; and the same is true of the common definition of line.

Should it be replied that it is curious that correct geometrical formulas have been derived from incorrect definitions, the answer is that the incorrect definitions never were used in practice. When the first theorem is proved, the incorrect definition of a line is abandoned, for a drawing is made of lines having visible width, and these are substituted in practice for the impossible lines of the definition.

Still it may be urged that since the width of the line does not become part of the geometrical solution, it follows that the width can be conceived as non-existent. Try to conceive absolute void if you can. Einstein has said: "In the first place, we entirely shun the vague word space, of which, we must honestly acknowledge, we cannot form the slightest conception, and we replace it by 'motion relative to a practically rigid body of reference.'" It will be observed that Einstein here regards conceivability as essential.

When an engineering student takes up calculus he again encounters some definitions that seem to indicate that man, or at least mathematical man, can reason about inconceivable things. Whether an infinitesimal be defined as an inconceivably small quantity or as less than any assignable quantity, the definition amounts to the same thing. Perhaps it is the hopelessness of reasoning about inconceivables that staggers the beginner in calculus. Very soon, however, he finds that the definition has been abandoned, and that strips that are quite respectably thick are used to illustrate infinitesimal parts of an area. Here the invisible Euclidian line has not only become magnified with visibility but has actually taken on a measurable width, for a large number of these infinitesimal strips (or physical lines) are supposed to make an area of any desired magnitude.

In passing it may be remarked that much of the initial difficulty about calculus would vanish were an infinitesimal defined as being the least measurable length, area or volume. Then a conceivable unit would take the place of the inconceivable thing that the definition vainly strives to introduce to the beginner.

Perhaps the most important single feature of Newton's mathematical philosophy is his conception of lines as possessing width and thickness; for, after all, his infinitesimal widths and thicknesses amount to nothing else than just that. For nearly 20 centuries the Euclidians had ignored all of the dimensions of a point and two of the dimensions of a line; then Newton undertook to see what would happen if some serious consideration were given to them, and his amazing calculus resulted.

If it sounds strange to speak of a point as having magnitude, read some of the modern physics in which nearly all phenomena are described in terms of the electron, which is the smallest known element of matter. There you will repeatedly encounter such expressions as "material point," "point mass," and "point charge." The dimensionless point of Euclid has not only grown into the infinitesimal cube of Newton but into something possessing mass and energy. Geometry has begun to lose its original static aspect and has become kinetic. Geometry never was really divorced from motion, although many of its devotees did their best to make it appear so. So gross was matter that they tried to wing their way into a pure space where such grossness did not exist. And we must concede that many of them soared so far aloft that the wings of their imagination finally found no support.

If it seems futile to discuss definitions that are clearly never taken literally, remember that many an inconceivable statement seeks refuge from logical attack by rushing to the side of the inconceivable definitions of point, line and infinitesimal. When, for example, you object to time as a fourth dimension of space on the ground of inconceivability, behold Euclid's ghost confronting you with his inconceivable geometric elements, and you are abashed.

When men undertake to reason about inconceivables, Logic bows an exit.

H P Gillette

The Economics of Grading and Paving Operations in Highway Construction

A Few Plain Statements From a Highway Contractor

By A. STELLHORN
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THE fundamentals underlying the economies of any construction or manufacturing operation are largely the same. Road building operations must conform to these common fundamentals and in addition adjust themselves to some additional hazards and limitations, which in the opinion of some almost remove road building from the realms of legitimate business and place it in the same class as gambling and playing the stock exchange.

Major Requirements. — That road building operations may be efficiently and economically carried on there are five major requirements which must be met.

a. Suitable equipment must be used.
b. Efficient personnel must be employed.
c. Good management must be secured.
d. The weather must be such that the work in question can be carried on.
e. The engineering supervision must be competent.

The first three requirements are under the control of the contractor and the nearer perfection is attained along these lines depends upon the ability and experience, and to some extent the financial strength of the individual contractor.

The hazards involved under the last two headings, "The weather" and "Engineering supervision," must be faced as something that cannot be controlled. Good weather and efficient engineering supervision are highly to be prized and should be utilized to the maximum possible.

Bad weather and poor engineering supervision must be borne with and the bad effects minimized to the greatest degree possible. However, as bad weather and poor engineering supervision do materially limit the total amount of work that can be done in a year, they cannot be ignored, but must be allowed for in laying out a season's construction schedule.

Influence of the Weather Conditions on Paving and Grading Operations.— It is not conceivable that it will ever be possible to do grading and paving construction under factory operative conditions, and therefore it will never be possible to approximate the efficiency that is being obtained in many of the manufacturing concerns.

To begin with, let us determine the effect of the weather on employment. In this section of the country there are somewhere between 120 and 160 days in a year in which, under the current specifications for public works, concrete pavement can be constructed and about 225 days in which grading operations can be carried on. These are not the number of days the contractor might find it expedient to work, or the actual number of days the engineers will allow work to be carried on.

The days lost for paving operations in this section include not only the loss of time during the winter months, when no work can be carried on for comparatively long intervals of time, but also the days lost during the normal working season due to low temperature and rain.

The reason for the much larger number of days for the grading operation is due to the fact that rain only occasionally closes down grading operations and that much greater frost action can be disregarded here than in the paving operations.

Today any contractor who operates in this section knows that his equipment and men can only be efficiently employed somewhere between 40 to 75 per cent of the 300 nominal working days of the year.

Engineering Supervision. — There must be cooperation and understanding between the contractor and the engineer or work will not progress satisfactorily.

This does not only mean that adequate lines and grades must be furnished the contractor so that no delay is caused on account of these, but that the engineer is alive to the problems involved in any given operation; that extra work if required is decided on in time to avoid delaying the general progress, and that the small differences between engineer and contractor, that invariably arise on any job, be expeditiously and justly decided.

The engineer invariably takes a good big portion of the credit when good progress is made on a job and excellent quality obtained, and furthermore, he probably deserves all the credit he gets under such circumstances. But when work does not proceed properly and poor progress is made, the engineer is very prone to pass the buck. Whereas, he is probably as much to be blamed in the one instance as he is to be praised in the other.

Another point that comes under engineering supervision is the making and paying of partial and final estimates on the work. Unless a contractor has unlimited credit his partial or monthly estimates must finance his work. Laxness and delay in making and paying these partial estimates are apt to not only embarrass the contractor financially but actually to seriously hurt his credit, and when that happens it is reflected back on the job. A contractor whose credit is poor will also be a contractor who makes poor progress on his work.

The engineer is the go-between, between the contractor and the public. He is to see that the contractor does his work according to plans and specifications and that the state receives 100 cents' worth of work for every dollar expended. The engineer has no moral or legal right to ask for anything more than that called for by the contract, just as he can be satisfied with nothing less.

The paving contractor is in a rather peculiar predicament. He has a bunch of engineers and inspectors on his work all the time, but it does not mean a thing; if the pavement is rough, he either donates it to the state or replaces it; if under thickness the same process holds good, and if under strength, although he has not one thing to say about proportions, time of mix, water content, method of compacting, etc., he is told to add 10 per cent of additional cement to bring it to the required strength.

However, if all the requirements laid down are followed and the resulting pavement is too thick or the strength much higher than required the contractor is a wonderfully fine fellow and—that is that.

The trick is to give the engineer a smooth pavement of the required thickness and strength without undue donation if any. This is not always easy at that. I am thinking of a 7½-mile pavement, 20 ft. wide, that satisfied everybody while being built, but when cored it averaged ½ in. over thickness. Just figure a minute and see how much wasted concrete was in that job, something like 1,200 cu. yd., on the equivalent of over 6,000 sq. yd. of standard pavement, or over 12,000 hard dollars thrown away. If a 7-in. pavement is called for, there is no sense in giving the state a 7½-in. one. The margins

on which pavement construction is now done are too small to deliberately throw away $1,600 per mile.

How to Get Required Pavement Thickness.—The only solution is for the contractor to satisfy himself that he is getting the required thickness and making the engineer see it his way.

My own peculiar way is to set the screed of the finishing machine and the subgrader absolutely dependent on each other then subgrade a section of grade and check for the required thickness by running the finishing machine in front of the mixer and testing the grade. This may seem somewhat of a nuisance, but it is apt to pay big dividends. To my notion a scratch board is an abomination and usually means, if conscientiously used, a grade from ⅛ to ⅜ in. low.

The whole question of extra thickness and extra cement is of vital importance to the contractor. Some engineers seem to feel it their duty to obtain more concrete than that called for; others seem to be particularly pleased when additional cement is used.

A job that has ½ in. greater thickness than called for, or one that has a material over-run of cement, has had just as poor engineering supervision as one that is under thickness and that has been skimped in the amount of cement used.

It has always seemed to me that the way to specify concrete proportioning is a given amount of cement to a cubic yard of mixed concrete and any method of control to obtain that result is all that is needed or wanted as far as cement content is concerned.

The uncertainty of what will be asked for or insisted on for any particular job makes for higher cost and decreased efficiency. If all the work of a contractors' organization could be done under one man it would not mean so much, but today, when an organization will build four to sixteen different jobs a year in as many different localities and probably all under different engineers, these questions begin to be of real importance.

There is no reason why concrete cannot be specified as definitely as any other building material.

All that a contractor can ask for is that the plans and specifications state clearly what is required. Anything which tends to cloud the intent and meaning of the plans and specifications opens a way for bickering and misunderstanding.

The building of the concrete pavements has been standardized to such an extent that the contractor knows how smooth the pavement must be, how thick it must be and he is often told how strong it must be. All the ingredients that go into the making of the modern pavement are specified and standardized. The quantity of water, sand, stone, cement, steel, the methods of preparations, handling, etc., are specified in detail.

It would seem a simple thing to determine just how to proportion and mix and how to deposit and finish the concrete, just how to finish the subgrade to get any predetermined thickness of pavement. It should not be necessary that all these things must be redetermined for each and every job.

As I see it, the weather is the big gamble for a grading and paving contractor with engineering supervision running a close second. There is, however, this ray of hope, that even if we cannot improve the weather conditions, we can gradually improve the engineering supervision.

Grading Operations.—Grading operations can be classified under the following four subdivisions:

1. Excavating.
2. Hauling the excavated material to the fills.
3. Leveling the materials placed in the fills and rolling same.
4. Finishing the grade (not including subgrading for pavement) slopes and ditches.

Equipment.—First the units used must be in keeping with the kind of work to be done. This applies not only to the total amount of work to be done but also the kind of grading whether earth, sand, gravel, boulders or solid rock. In a general way the harder the digging, the larger the units to be employed. Rock does not need to be broken to such small dimensions and can be handled easier, and shale, cemented gravels and similar materials can often be excavated by larger units without blasting, whereas this would be impossible with smaller equipment.

Of course if the quantity of work is there, large equipment is always more economical to operate than smaller equipment of less capacity, no matter what kind of material is to be moved.

However, the excavating equipment must be in keeping with the hauling equipment. Under the highway specifications of many states, and Ohio is one of them, there is no such thing as cast dirt. It must be spread in layers usually about 1 ft. in depth and rolled. Furthermore, it is becoming increasingly difficult to move excavating equipment that weighs between 25 and 40 tons over the improved roads. As long as the roads were unimproved and the bridges were braced or detoured around no one in authority seemed to care how heavy a power shovel was. But today the highway authorities are beginning to ask embarrassing questions about weights of this kind of equipment.

In organizing a grading outfit, remember that with a good operator a shovel will deliver between 80 and 90 per cent of its capacity, day in day out, provided you can keep trucks or wagons under the shovel. Take the dirt away and almost any shovel will make the contractor money, vice versa if the dirt is not taken away as fast as it can be excavated, no excavating piece of equipment can operate to any degree of efficiency.

Leveling and rolling operations are such that usually the capacity of the rolling and leveling equipment is much greater than the excavating and hauling equipment and it is hardly conceivable that serious delays could be caused at this place. Caterpillar tractors with graders or bulldozers and gasoline 3-wheel rollers seem to be standard equipment on this work.

Finishing Grade Berms and Ditches.—Large losses and serious delays are often caused by sloppy work in the rough grading. Under normal conditions, it should not be necessary to bring back power shovels to do this work. A tractor and grader should be able to move all the earth necessary. This does not apply to many of the repaving jobs where large amounts of earth must be borrowed to build new berms.

In conclusion, I would say, never move a yard of dirt a second time if it can possibly be avoided. Naturally do not move direct for which you are not paid. Also that a power excavator will move dirt very much cheaper than man power. Do not leave too much to clean up.

Paving Operations.—Paving operations can be classified under the following seven subdivisions:

1. Setting and moving forms.
2. Fine grading, including rolling.
3. Unloading and proportioning materials.
4. Hauling of materials.
5. Mixing and placing.
6. Finishing.
7. Curing.

Moving and Setting of Forms and Fine Grading, Including Rolling.—If the original rough grade has been carried not to exceed 0.2 ft. high this is rather a simple operation. A good foreman, a form grader, a subgrader, a roller and a scarafier are the prime requisites. If hauling is done over the grade complications set it. These may be avoided by subgrading at night, or before and after the mixer shuts down.

There is a decided tendency for engineers to specify 500 ft. of subgrade to be completed in front of the mixer. I am not sure that this is always desirable. If a finished subgrade ever starts to rut the more that is completed before the mixer the more trouble is caused. Rain on a long stretch of finished fine grade can also cause real trouble.

Unloading, Hauling and Proportioning of Materials.—This is usually the place where paving contractors fall down. The mixer must have material in front of it or you can't build roads.

The materials can be unloaded by belt or clam shell or any other device proportioned by weight or measure; hauled on an industrial railroad or batch trucks, but material must be kept in front of the mixer.

The mixer will mix in a general way

more material than it will be economical to get to it. The placing of the concrete and steel should never be the limiting feature of a job. If good equipment is used and good operators hired, mixing and placing of concrete becomes more or less a routine affair.

Finishing was beginning to be comparatively easy, so now we have impressed joints both longitudinal and transverse, dowel contraction and expansion joints. Whether these things are worth the price or not I do not know, another neck has been introduced into the operation of paving; and finishing now must be watched or production is curtailed.

Curing.—There is so much difference of opinion and practice in curing concrete that unless some extremely unusual method is employed all the contractors can do is to allow a reasonable figure for the cost and then satisfy the engineers.

As far as economies for the contractor is concerned, any method which will leave him get rid of the curing quickly is desirable, even though the first cost is a trifle high.

There is usually more bickering and misunderstanding about the curing of a concrete pavement than all the other operations combined.

Coordination of Operations.—Each individual and separate operation of building a concrete pavement is simple and easy. The real difficulty is to coordinate all of the operations. They all must go on simultaneously if volume is to be obtained. System and coordination, these are the secrets, if there are any, of volume production and unless volume production is obtained the modern contractor cannot make any money, and unless he makes money he goes out of business.

Periodically groups of engineers make time studies on road construction and then road builders are told just what poor managers they are. They report 100 sq. yd. of pavement lost due to delays on subgrade; 300 sq. yd. due to no material at the mixer; 50 sq. yd. due to the delay caused by moving water hose, etc. I am afraid that some of these well meaning critics forget that the contractor is building roads to make money, not to make records. What he is interested in is a balance on the right side of the ledger at the close of the year, not letters of appreciation. Letters of appreciation and records are very fine, but they keep no man in business any length of time, at least not on public construction, where the low bid is practically the only requirement needed to be awarded a job.

This is no plea to discredit good management, in fact poor management will in this day and age put a contractor on the rocks in a hurry. But often the thing a contractor does seem to the outsider to have no rhyme or reason to them but still be good business in a financial way and also expedite the construction of the pavement.

It may perhaps be just as efficient to work twelve trucks on a road concreting job to maximum efficiency and allow for some loss in the mixing and finishing, as for the contractor to overweigh himself with hauling equipment just to keep the mixer busy.

Furthermore construction organizations are like football teams, they must be developed over and over again, year after year. The best results are obtained if they are built up to their maximum efficiency during August and September, when normally the best weather conditions prevail.

One mile a week of 18 or 20 ft. Illinois type road is fine, but better financial results usually prevail if a schedule of two miles every three weeks is actually adhered to. This works out to something like 12 miles of road paving per crew in a year, allowing about two weeks for moving from one job to another. Unfortunately here in Ohio and neighboring states, there are very few, if any, 12 mile road jobs, and on the few that do come up the engineers usually specify that two concreting crews must be used, and here efficiency and economy is again shot to pieces.

To a certain extent efficiency and economy have a very different meaning under different circumstances. I remember some eight years ago when under the direction of L. C. Herrick, then Highway Director of Ohio, I was building by force account a 12¾-mile section of the C. C. C. Highway. The section involved a heavy grading, numerous bridges, long haul and was a very high type of pavement, 4-in. big brick with asphalt filler on a 5½-in. reinforced concrete base. When the job was about 75 per cent finished a great hue and cry was made that the work was very inefficiently carried on, materials wasted, men loafing, etc. In fact the legislature and the governor took serious notice of this and an investigating committee was appointed and things generally made unpleasant for the men in responsible charge of the work. A few months later, when the work was completed and all bills paid and a group of special auditors had gone over all the accounts, it was found that a saving of $104,000 below the engineer's estimate had accrued to the state. The work was built in record time, of the quality there has never been any question and a large saving made. Was the job carried on efficiently, or was it not? I am sure it was not even approximately 100 per cent efficiency. There was waste, there was idleness, there was to some extent mismanagement, but a good job was completed in record time and money saved.

Perhaps a job is run efficiently if it makes money, and inefficiently if it does not. That is at least the acid test as far as a contractor is concerned. The chief engineer of a large concrete pile company made a very trite remark to me sometime back. He said, "I have found it does not pay to try and get every dollar out of a job." I believe he is right. Organize to get volume, take care of the large items, systematize and coordinate, do not get in your own road in this way, you will be able to skim the cream off of a job even if you let some of the skimmed milk get away. Volume and coordination mean economy and efficiency and these spell prosperity for the road builders of today.

Roadside Planting to Improve Main Highways

The Act, passed at the last session of Congress, which permits the Federal Government to pay half the cost of wayside planting along Federal-aid highways, will give considerable impetus to the movement long fostered by women's clubs and other social organizations, and its effect will quickly be evident in an improvement of the appearance of the main interstate roads, according to the Bureau of Public Roads of the United State Department of Agriculture.

Latest available figures show that 25 states have no laws governing tree and shrub planting along highways. A few of the remaining 23 have good laws, but the majority have indifferent ones.

The Massachusetts Department of Public Works and the highway and forestry departments of other states, have already demonstrated how much can be done at small cost to beautify the roadsides by judicious planting of native trees, shrubs, and perennial flowers.

The Massachusetts Department is empowered by law to make roadside improvements, the work including such planting, replacements, and care as may be necessary. When a road is laid out as a state highway, it is generally made sufficiently wide to provide an area on each side of the traveled portion for roadside improvement. No tree, shrub, or plant within such a highway can be cut, removed, or new ones added without a permit from the highway department.

The work of roadside improvement in Massachusetts is done by the maintenance division. The cost is included as a part of the regular maintenance expenditure of the state. The state has a nursery at Palmer, where trees and shrubs are propagated and where the highway landscape supervisor trains men in the care of trees and roadside beautification.

Public acquisition in all states of suitable tracts of land along the highways for state parks, for purposes of recreation and conservation of timber and animal life, and the acquisition of small road-bordering strips and plots for development of parkways and parklets, says the bureau, would enhance considerably the appearance of the roadsides.

Materials and Control Methods on Economics of Asphalt Construction

Improves the Product and Lowers the Cost

By MALCOLM H. ULMAN

Assistant Engineer of Tests and Materials Investigation, Pennsylvania Department of Highways

THE value of a product is measured by its service, so it is not always the best policy to choose those materials or types which have the lowest initial cost, unless information is available as to their durability under the estimated field conditions. Quality as measured by durability for the estimated traffic should not be sacrificed for economy. The question naturally arises as to how satisfactory quality can be secured. It is only obtained by a thorough, properly applied, knowledge of materials, mixtures and methods of use. Progress is accomplished through developments and this can only be obtained by research.

The importance of following specifications and instructions cannot be over emphasized for the neglect of what may be considered unimportant details may be the causes for subsequent failures. The writing of specifications should be based on a knowledge of materials and results obtained when properly used. It is a serious error for one community to use another's specifications, where different climatic or traffic conditions exist. Each community has its own problem, which should be solved by investigations conducted preferably through laboratory and field service tests to determine the proper use of materials and mixtures, so as to affect the greatest economy and meet their individual conditions.

The Pennsylvania Department of Highways is constantly experimenting and conducting research investigations with the thought of improving products or methods in order to affect increased economy.

Materials.—We consider it of utmost importance to determine the availability of local materials. Material inspections are made within distances of economic haul of the project after authorization for construction has been issued. The engineer assigned to this work must have sufficient highway experience to enable him to judge when deposits are practical for development and which are the most economic to use. When deposits or lodges appearing to have possibilities are found the most available ones are further investigated as required by dynamiting or excavating to determine the extent and uniformity. The amount of time and expense necessary for investigating varies on different projects. This is naturally governed by the length of haul, length of contract, yardage of material needed and cost of commercial materials available for the work.

Samples are collected and reports issued by the investigator furnishing all data necessary together with sketches giving plan and profile of the deposit. Upon completion of such an investigation there is issued what we designate as a blanket report, which includes a summary of all deposits investigated and straight line diagram giving data as to location of deposits in reference to the project. The information pertaining to approved local sources is subsequently furnished to prospective bidders with the proposal form. For example: in one year we surveyed 868.7 miles of proposed construction for materials and located 323 deposits of which 57 per cent were approved for development. Rejection were based on:

1. Material's failure to comply with requirements of specifications based on laboratory tests.
2. Nonuniformity of material in deposit.
3. Insufficient amount available for economic development.

A large percentage of approved local deposits have been developed by the constructors, and when local deposits are available the bids reflect this condition. The local material development relieves the Constructor of any worries about materials being available when needed, for delays may be experienced at any time by uncontrollable conditions in commercial transportation through various causes.

Sands of the required quality and grading for bituminous construction are not so plentiful, but when they are located there is a considerable economy effected. It may not always be possible to locate sand deposits of suitable grading for use alone to give the quality required, but the material in these deposits can usually be utilized in combinations with commercial sands of finer or coarser gradings as conditions require. To cite an example, on one project it would have been necessary to truck materials for a distance of eight miles from a railroad siding to the asphalt plant site and over a toll bridge. A very intensive investigation was made on this project and we were fortunate in being able to locate stone of suitable quality for the binder coarse and sand of excellent quality and grading for both the binder and sheet asphalt topping. The sand deposit was found within one-quarter of a mile haul of the site on which the Constructor subsequently located his asphalt plant.

The asphalt cements are fairly well covered by standard specifications and the Division of Simplified Practice of the United States Department of Commerce have effected economies by reduction in grades through specified penetration limits. There is room for improvement in specifications as the quality is now measured to a large extent by indirect tests. Research organizations recognize this and committees are studying the problem of developing more satisfactory tests with the view of directly measuring essential characteristics.

Asphalt Surface Treatment. — The standardization of specifications for asphalt surface treatment presents a more difficult problem for various organizations require different initial results. In Pennsylvania we require the cold surface treatment materials to be quick drying and such is essential under our practice as we only oil in half widths, and one side of the roadway must be dry before the other half is oiled. This practice is followed in order to reduce inconvenience to motorists and danger of skidding over freshly oiled surfaces.

We have discontinued the use of any hot surface treatment oils as we have found in our investigations that better results can be secured by cold application oils. When hot surface treatments are resorted to there is a possibility of building up mats due to the difficulty in controlling a thin application of the hot oil. This type of surface treatment is therefore liable to become wavy, so that a rough riding surface eventually results, and the only remedy when this occurs is to scarify and resurface.

The more generally used asphaltic cold patch materials cover asphalt cements of proper consistency cut-back with naphtha. Their method of use will be discussed later. In addition there is coming into greater usage premized aggregates with asphalt cement and small amounts of naphtha or combinations of aggregate and asphaltic malthas for cold patch work. These latter materials are of higher initial cost but effect an economy in labor in that no additional mixing is required when received.

Asphalt emulsions for cold patch work also give satisfactory results. In highway organizations it is necessary to stock materials for repairs when conditions require their use. If temperatures are obtained below freezing there will possibly occur a loss in emulsion through the water freezing and consequent breaking of the emulsion so that it is impossible to remix.

Methods.—It is unfortunate particularly in the northern sections of the country that laying of bituminous surfaces occurs during the fall when temperatures are low. This is due to the constructors working on the base construction during the summer months. Successful results cannot be expected unless proper compression of the asphaltic surface mixture is obtained. It is, therefore, necessary to carefully regulate the temperature of the mix so that when placed the temperature will be satisfactory for obtaining the necessary compression with subsequent density. Under these conditions of low temperatures it is necessary to guard against laying excess quantities of the asphaltic mixture ahead of the roller to avoid cooling to a deleterious extent prior to compression.

It has been my observation in consideration of highway construction that asphaltic concretes in which uniformly graded stone is used having a maximum size of 1¼ in. that better results are secured under service compared to sheet asphalt mixtures. This is probably due to concentrated traffic over comparatively narrow highways compared to city streets, and greater stability being secured through a well graded coarse aggregated bonded with asphaltic mortar. Slight variations in composition in this type of mix does not have such a marked deleterious effect as in the case of sheet asphalt.

The use of a flush cost of asphalt cement with a covering of chips and rolling as a seal coat over asphaltic concrete mixtures furnishes better results in service and economy than mixed seal coats. If the asphaltic concrete is chilled prior to application of the mixed seal coat or the mixed seal coat chilled prior to laying a good bond cannot be expected. Another factor which favors the flush seal coat is the subsequent use of chips for covering, which roughened condition reduces the tendency to slipperyness during wet weather.

It is our practice that immediately after the raking of sheet asphalt mixtures and prior to rolling, the entire surface is carefully struck off with a straight edge having an approximate length of ten feet to which is attached a long handle. These straight edges are operated at right angles to the center line from the shoulders or berms of the roadway and after the laborers are experienced very successful results can be obtained. A much better contour with less tendency to honey combing can be secured by this method and economy can be obtained due to less skilled labor being required, especially rakers. This was first used in Pennsylvania and its practicability discovered by one of the department's inspectors, who was in charge of a twenty-mile sheet asphalt project. The results obtained were so superior to other projects that we adopted it as a specification requirement.

The use of mechanical finishing or screed machines is being experimented with in some of the southern states in the construction of fine graded asphaltic mixtures. I have not made any personal observations, but if this method is perfected for such types economies should be effected.

Bituminous Macadam. — Bituminous macadam penetration furnishes excellent service under moderate traffic when properly constructed. This type of pavement although apparently easy to construct requires the utmost attention to details of construction procedure, if successful results are to be obtained. Aggregates must be of proper grading for if the coarser stone course contains an excess of finer sizes sufficient penetration will not be obtained or if the void spaces are excessive the asphalt cement will flow to the bottom instead of furnishing a uniform coating on the aggregate. The key or second application stone should not be of too coarse a maximum size for when this occurs the bottom course stone are pushed apart under compression with consequent breaking of the bond of the asphalt cement. The aggregates should be clean and dry when the asphalt cement is applied and this cannot be over emphasized. The air temperatures should not be excessively low. It is excellent practice to prohibit the application of asphalt cement when temperatures are below 50 degrees F. If low temperatures prevail the aggregate should not be too cold at time of application, or the asphalt cement will congeal so the required penetration will not be obtained. The pressure distributor should be equipped with a stick calibrated to give information as to gallons in the distributor per inch of depth in order to check the rate of application per load. We have found it to be good practice to use wooden side forms until ready for rolling when the lumber is removed and back filled with stone to act as side supports and thereby prevent reduction in edge depth through pushing. It would be excellent procedure if practical for more successful results if the pressure distributors could be equipped so that the manifold was offset from the side so the compacted stone could not be disturbed by the comparative narrow tread of the wheels of the distributor prior to application of asphalt cement. The pressure at the manifold or nozzle is not the same as in the tank of the distributor, and if the pressure gauges could be located so as to obtain the actual pressure of the asphalt cement in the manifold rather than in the tank better control could be obtained.

Our water bound macadam construction is designated as bituminous surface treated macadam, for we surface treat with a cold application all macadam construction. It is essential for successful results that excess bituminous material be avoided and after application of bituminous material, chips should be spread and rolled. In our retreatment application using asphalt cut-back with naphtha there is applied 0.25 gal. of oil, for excess quantities are not required and if used the economy is reduced and drying retarded. A factor which is often not properly considered is the size of chips to be used. We have found that chips of a maximum grading which will adhere to the bituminous treatment after rolling furnishes the most satisfactory results. Our practice is to use chips having a maximum size of 95 to 100 per cent passing 1-in. circular openings. This is due to the less slippery surface resulting under wet pavement conditions and less tendency to crush under rolling and traffic conditions.

Service Test Roads.—In line with Pennsylvania's research activities and in view of improving the practice or methods and so affecting economy we constructed a short stretch of macadam as a service test under the usual construction practice except that we used an asphalt emulsion containing equal parts of asphalt and water instead of water for the final puddling. This section of pavement has now been under service for two years with good results, although the traffic is light. The method appears to have possibilities with resultant lower costs.

Surface Treatment. — Our surface treatment schedule is of considerable magnitude for in 1927 there was a grand total of 2,829.87 miles or 26,935,373 sq. yd. of pavement surface treated or oiled and to accomplish this there was required 9,377,110 gallons of bituminous materials. It is absolutely necessary that constant thought and attention be given to effect economies in such a large program and this we have accomplished for the costs during the past three years have steadily decreased. This is attributed to proper scheduling, planning, organizing for the work and the use of mechanical equipment whenever possible.

In reference to the scheduling we require our surface treatment applications to start about the latter part of April and same must be completed prior to July 1st, so as to reduce the inconvenience to motorists during the touring season. We are now experimenting with a fall surface treatment schedule, for we feel that by this procedure greater waterproofing of the macadam will be obtained over the winter months and reduce the required amount of spring patching.

Repairing Pavement Breaks. — The use of cold patch materials is an

effective means for rapid repairs when breaks occur in pavements. It is essential to be organized for immediate repairs as modern traffic demands smooth riding pavements and precautions must be taken to avoid increased damage after breaks occur by impact of traffic through lack of surface smoothness. The simplicity or ease of use of this class of material has in many cases resulted in carelessness through lack of knowledge of the materials' limitations. For successful results the aggregate should be dry except when emulsions are used, excess bitumen should be avoided and the material after mixing should be cured prior to use. To amplify on curing the freshly mixed material if placed immediately will probably push under traffic. The prepared should be tacky prior to placing. The greater tackiness when placed the less possibility of displacement under traffic. The length of time required for curing depends on temperatures, as the naphtha in the case of cut-backs naturally evaporates more rapidly at the higher temperatures.

Control of Materials.—The control of materials or products is dependent on inspection. The inspector assigned for such work is one of the most important units in an organization. The inspector should work with the constructor in the prosecution of the work and be tactful in transaction of the work by assisting in obtaining economic and efficient plant operations. He should be firm in obtaining economic and efficient plant operations. He should be firm in enforcing the requirements of specifications, but avoid arbitrary acts.

Plant control of bituminous mixtures should be a requirement of every highway organization, for only by such can they be assured of the proper application of their specifications. The obtaining of materials and uniform mixtures complying with specification requirements or of the design formula for the intended work can only be accomplished by plant inspection. The American Society for Testing Materials recognized the importance of this procedure and this year published a tentative standard covering "Recommended Practice for Bituminous Paving Plant Inspection." It will, therefore, not be necessary for me to go into details as to the procedure for this method covers the latest development. In addition to the control, data is obtained by issuing daily reports for permanent records covering nature of materials, mixtures, yardage laid, etc., and suggested report form is included in this publication.

It is essential for proper plant control that the inspector be furnished with the necessary apparatus for making tests to control the quality of the materials. It is excellent practice to supply equipment for making analyses of the mixtures in these cases where plants are erected at a distance from the central control laboratory and delays may be experienced in receipt of samples. We have had constructed very compact boxes approximately the size of a small steamer trunk. These boxes are partitioned and cushioned inside so the apparatus can be quickly and safely packed. These boxes are fitted with handles and locks, which facilitate transportation from one project to another.

Plant control is an insurance on the investment and its value cannot be over estimated. I have already cited a number of its advantages but have not discussed its value for determining changes in the quality of material. In this connection we had under contract a sheet asphalt project of considerable yardage and the constructor had built a storage tank partitioned in the center one side was used for fuel oil and the other side for asphalt cement storage. The penetration specified for the project was 40-50 and was uniformly maintained until one morning the inspector was surprised when he obtained a result of 100 penetration on his first test. An immediate investigation was made and it was found that the night watchman in filling the fuel oil tank had permitted it to overflow into the asphalt cement storage with consequent softening of same. This caused a loss to the constructor in pavement replacement and materials, but he was grateful that it was detected before excess yardage of unsatisfactory mixture had been placed which would have required replacement.

Factors Affecting Plant Operators.—There are certain pertinent factors which affect economies in plant operation and control which are in many cases overlooked, viz.:

1. In investigating possible plant locations choose one that provides ample storage facilities.
2. Delays by commercial carriers should be considered and sufficient materials stocked to avoid shut downs.
3. Clam shells should be used instead of hand labor to reduce unloading costs and demurrage.
4. The materials should be so stocked in reference to plant site and delivery point so as to reduce extra handling to the minimum.
5. Aggregates whenever possible should be stocked under cover to avoid excess fuel in drying.
6. Fuel oil is generally more economic than coal for heating purposes due to less waste with quicker heating and better control of temperatures.
7. The lowest temperatures should be used within the specifications that will furnish a mix so that proper compression will be obtained for the required stability. This is particularly true of asphalt concrete when long hauls are involved for with the maximum temperatures there is obtained greater segregation with increased difficulties in laying.

The practice of assigning inspectors to refineries for inspection of bituminous materials prior to shipment is an excellent procedure and is recommended when economic conditions make same feasible. The inspection, however, should cover more than sampling of still or storage tank as men assigned for such work should be trained in routine testing and interpretation of tests under specifications, and they should be given the authority to release material inspected based on their tests at the plant.

Asphalt cements of different consistencies are required for the same types of construction, when projects are located in sections where different climatic and traffic conditions exist, and consistencies of surface treatment and cold patch materials are subject to change dependent on the season of the year when used or applied. These conditions can be readily controled under this procedure of inspection and we have found it to work most satisfactorily to all concerned.

It is the best practice in this procedure to have additional samples of the material tested submitted to the laboratory for check tests, and also material on arrival at destination should be further sampled in order to have data available both as check on original material inspected and material as actually used in the work. The procedure precludes the possibility of any delays to the constructors or controversies with the producer when material is received on the project.

Conclusions.—Materials, methods and controls are interdependent and only by their proper application can successful results be obtained with economies in construction.

Acknowledgment. — The foregoing paper was presented at the 7th Annual Asphalt Paving Conference held at New Orleans, La., Dec. 3-7.

90 Arrests per Day for Violating Pennsylvania Motor Vehicle Laws

Arrests in October for violation of the Pennsylvania motor vehicle laws, totaling 2,689, resulted in imposition of fines amounting to $33,869.50, of which $29,370.00 is returnable to the state treasury and $4,499.50 to the local authorities. Of these arrests, 112 were made for operating while under the influence of intoxicating liquor; 2,390 were disposed of by summary conviction before justices of the peace, magistrates, etc., and 187 were returned to court. The largest number, 814, were made for violations of Article 10, which contains the traffic provisions of the vehicle code, and are largely the result of carelessness or thoughtlessness on the part of operators in observing the rules of the road; 754 were made for reckless driving and speeding; and 122 for violations of the lighting provisions. The remainder are comprised in various minor violations.

Spreading Rock Asphalt

Concrete Finishing Machine Used on Tennessee Job

By JOHN L. HUMBARD
President John L. Humbard Construction Co., Knoxville, Tenn.

IN executing a contract for the Tennessee Highway Department for nine miles of concrete base and rock asphalt top pavement on Route No. 1, Cheatham County, Tennessee, the contractor, the John L. Humbard Construction Co. of Knoxville, Tenn. employed a new method for spreading "Kyrock," the rock asphalt purchased for this project. This method involved the use of a standard make concrete finishing machine with the addition of a fluffing or raking device which can be purchased from the manufacturers of the finishing machine. The only additional change to the finishing machine was to raise the screed plates so as to secure the proper thickness for loose spread of Kyrock prior to rolling.

The concrete base was 7in.-5in.-7 in. (parabolic curve) with 9 in. x 1¼ in. integral curb. The finishing machine was operated in the usual manner on this curb. The Kyrock was dumped directly on the concrete base and distributed with forks to the front of the machine.

Fig. 1 shows the result obtained in the spread and the noticeable absence of lumps in asphalt and the perfectly smooth and uniform spread can be easily seen.

Fig. 2 shows a section after finish-

Fig. 1.—View Showing Results of Machine Spreading

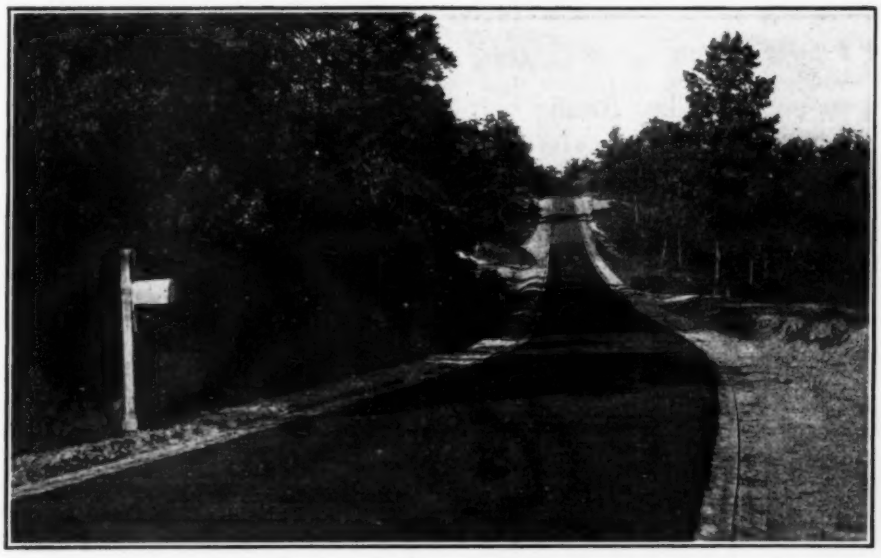

Fig. 2.—Section After Finishing Machine Has Gone by and Before Initial Rolling

Fig. 3.—Rock Asphalt After First Rolling

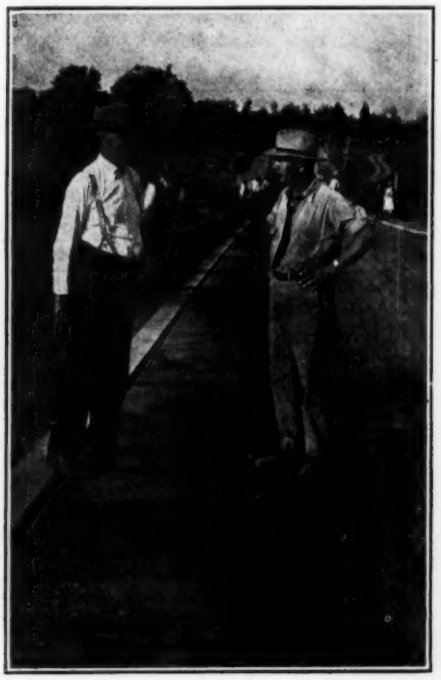

Fig. 4.—Concrete Base After Application of Paint Coat

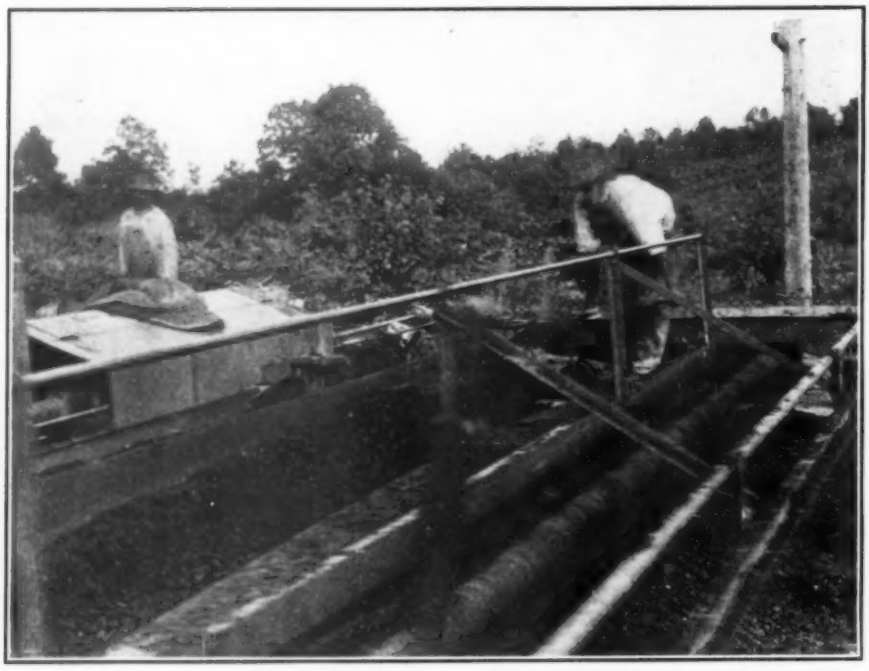

Fig. 5.—Finishing Machine with Fluffing Device

ing machine had gone by and before receiving the initial rolling. Note the way the material stands up above the edging course and the uniform result obtained.

Fig. 3 gives a view of the rock asphalt pavement after the first rolling and it is particularly interesting to note the absence of waves or corrugations in the pavement.

Fig. 4 shows the concrete base after the paint coat had been applied. T. L. Peters and J. G. Humbard, the men in actual charge of this project are also shown in this picture. T. C. Caveny was resident engineer in charge of this project.

Fig. 5 shows the finishing machine with fluffing device.

Our company is the first to use a finishing machine for spreading rock asphalt and the advantages of using this method are outstanding. We received a uniform yield in square yards per ton, the yield varying less than 10.1 sq. yd. per ton. A perfectly smooth riding surface was secured with a uniform thickness of asphalt. Our daily yardage over the usual hand raking method was greatly increased. The engineers of the Tennessee Highway Department are highly pleased with the results secured.

Cost of Burning Highway Right of Way.—Burning and clearing operations on state highways in California planned to aid in the prevention of fires were greatly extended in 1928. A total of 661 miles of highway right of way was burned under the direction of state highway maintenance forces. The cost to the state for the season has been $37,851, or an average of about $57 per mile.

Sand-Clay Roads

By T. L. PENDERGRASS
County Road Superintendent Durham County, N. C.

The name sand clay is given to a type of road surface that consists of natural or artificial mixtures of sand and clay loam. Out of these materials surfaces are constructed on clay or sand. The character of soil and sand varies so much you can hardly follow any set specification. You must take the best of each one, study it and use what seems best for the particular kind of soils or clays upon which you are building or may be available. Better results are obtained when you can more nearly follow the well established principles in this type of construction.

The requirements for success are that the materials be reasonably suitable in character to secure a bond sufficient to hold in dry as well as in wet weather.

To the engineer or road men who can successfully build this type of road has a broad field to work upon and will find it an interesting study. The idea should be to follow well defined principles as far as you possibly can and to always get the best material available, and use the best plans and specifications as a basis to work upon. To the average county road engineer specifications mean but little when it is impossible to find any material available which is called for in said specifications, but with the average local material you get better results by following the well laid plans in the building of untreated surface roads.

The materials that are usually used are the soils, sands and clays found upon the roads to be surfaced and this material varies greatly throughout the county and varies considerably in a few hundred yards at times in the same location.

General Principles.—There are certain principles in highway construction that can be applied with some modification to meet almost any type of soil. Most of the specifications for building sand clay roads are written scientifically and built under the most favorable circumstances but that means very little to the average road builder when none of the materials called for are available. He must use the best material available and must understand some of the characteristics and behavior of the materials with which he has to work.

Good drainage is absolutely necessary in the construction of sand clay roads. Proper sub-drainage and surface drainage must be provided. A great deal depends upon the sub-soil whether sand or clay. The amount of clay necessary is that amount which will just fill the voids in the sand. It may be approximately determined by the amount of water in the sand. Proper drainage must always be provided for, as hereinbefore stated.

How Best Results Can Be Obtained.—The construction of sand clay roads is a slow process. The best results can only be obtained by giving the road constant attention for some time after it is completed or until such a time traffic has it sufficiently compacted. In building a sand clay road where you have a sub-soil the road bed should be shaped to the desired crown. The clay is brought on to the road and spread in a layer of 6 to 8 in. at the center, tapering off to a thin layer to the side. It is necessary that the clay be thoroughly mixed with the sand. In many cases the clay is covered with sand and left for traffic to mix and compact. Quicker and better results can be obtained by harrowing and plowing the surface. It should be kept in shape by the use of drags or road machines.

Use of Screenings.—As a substitute for sand in building the untreated surface roads good results are obtained by using rock screenings or dust ranging in size from ⅝ in. to ¼ in. stone with the dust partially screened out. By preparing the road bed as for the regular sand clay, shaping it and giving it the desired crown, screenings can be applied at the rate of approximately 50 lb. per square yard and allowing traffic to compact. Where screenings can be obtained at a cost not greater than $1.50 per ton a good serviceable road can be built that will take the oil treatments more readily than sand and will be just as serviceable as sand clay and at a less price.

Acknowledgment.—The foregoing is taken from a committee report on county road construction, presented Jan. 17 at the 26th Annual Convention of the American Road Builders Association.

Aerial Mapping

An Aid to County Planning

By STANLEY ABEL
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THE past two years have seen not only great development in commercial aviation, but also a vast change in the popular attitude toward this new science. The notable and historic flight of Lindbergh across the Atlantic undoubtedly marks the change in public sentiment toward aviation and, to use an oft-recurring phrase, "the nation is rapidly becoming airminded."

Prior to this time the popular conception of aerial surveys and mapping has been strongly associated with the thought of military operations. In the early days following the great war, when commercial aerial photography was in its infancy, processes were expensive and results frequently disappointing. Experience and persistent research, together with a constant demand for photographic maps, have resulted in the development of several thoroughly practical processes available today.

The average aerial map is a compilation of individual pictures, each of which would be a true map were it not for the distortions and displacements which are characteristic of practically all photographs. The understanding and elimination of these errors has established the conclusive fact that satisfactory aerial maps can be produced by the skillful application of a difficult technique. In fairly flat country an aerial map may be made to a fair degree of accuracy with scarcely any difficult correction.

Aerial Maps Cost Less Than Ground Work.—In any event, the work involved in the aerial map is considerably less than the ground work which would be required to produce the same result. Cost data compiled in the mapping of certain municipalities indicate that the cost of aerial maps is approximately one-fifth the cost of maps prepared for the same purpose by conventional methods.

Aerial maps have distinct advantages over the best detailed line maps of cultured areas in that they show the entire area in complete detail, showing every building, tree, pavement and structure to scale. The quick delivery of aerial maps sometimes enables the user to begin important work and studies weeks, or months, ahead of the time which would be possible if surface surveys had to be made and maps drawn. An aerial survey of an extensive area can be completed in a matter of months instead of a period of years, as compared to a ground survey. An important feature also is the fact that the laymen is competent to read the maps as well as a trained engineer.

Uses of Aerial Maps.—Aerial maps may be used to advantage in county planning for the following studies:

1. Highway location and relocation.
2. Transportation studies.
3. Reappraisal for taxation.
4. Subdivision control.
5. Probably directional trend of improvements.
6. Forest and grain fire prevention.

The aerial map will be found of great value to all county departments, especially to the county engineer and road departments.

The county plan frequently emphasizes the necessity for a new connecting link between two cities or points of importance and it often happens that the intervening area between these points is composed of lands and property sufficiently improved as to make haphazard or arbitrary location of highways an expensive proposition. Here the aerial map, by showing cultural conditions for a considerable distance on either side of the tentative line, gives information that would be impossible to obtain otherwise and saves many right of way difficulties, as well as providing the county authorities a basis for reasonable argument in their efforts to obtain right of way and definitely establishes many facts which would be otherwise overlooked where determinations of values of rights of way are to be made either in the course of ordinary purchase or in condemnation suits.

Many of our county roads are located along section lines and are a series of right angle jogs which not only increase the danger element of ordinary driving but also serve to greatly impede the progress of traffic.

Saving in Relocation Work.—Again the aerial map shows data which might be tedious and expensive to acquire in the field and since all important details are apparent when studied in the office, the expense of several trial lines of relocation may be saved.

As the conclusions and determinations of the planning commission, relative to new highway location and construction, are usually made with regard to the recommendations of the highway engineer, the aerial map is of inestimable value to both parties in the location, and the estimate of construction costs, of roads and highways in mountainous country.

Topographic conditions, trees, brush and other verdure, often make location surveys very expensive, particularly where a number of trial lines have to be run to determine the most economic and satisfactory route. Drainage areas may be quickly and accurately computed from the aerial map, together with rate-of-run off data, removing a vast amount of guess-work and uncertainty from the design of drainage structures, the cost of which, on graded roads, sometimes amounts to as much as the cost of road construction itself. In run-off studies, because the aerial map actually shows the contact between one kind of soil and another, the various types of verdure and vegetation are often identifiable upon the map.

Transportation and Traffic Density Studies.—Aerial surveys in transportation and traffic density studies have recently been found of considerable value and no doubt will find greater application within the near future. While this method has, heretofore, been resorted to mostly in cities having congested traffic areas, the latter condition is by no means confined to cities alone. Many of our county trunk highways are operating to capacity at certain periods of the day and the relief is a serious, and in most cases expensive, problem.

The aerial map discloses much interesting and valuable information relative to mass movement and open spaces in heavy traffic which could not be shown by the ordinary methods of tabulation, and which, in fact, could not be shown by any method other than aerial photography.

An interesting survey of this nature was conducted upon a portion of the Maryland State Highway system recently reported in the proceedings of the seventh annual meeting of the Highway Research Board of the division of Engineering and Industrial Research, National Research Council.

Appraisal of Rural Lands.—Of even more significance is the application of aerial photography to the appraisal of rural lands. Usually the only information available is the fact that a certain parcel of land belongs to a certain owner and consists of so many acres, the boundaries of which are described.

From the appraisal standpoint it is highly important to determine the subdivision of this parcel. It must be known how much of the land is in pasture, how much is suitable for grain, how much is in orchard, and what portion of it is rocky and worthless. Because the aerial map actually shows the contact between one kind of soil and another, between one field and another, and because it actually shows the number of trees, vines, and buildings, and the location of public improvements and other objects, it forms the ideal basis for the necessary classification work which must precede an intelligent appraisal.

The appraiser, or his representative, takes the aerial map into the field and actually makes a note of the conditions he observes for each unit of the area as revealed by the picture. He knows the total area of the parcel in accordance with the record description. A planimeter factor is readily arrived at by means of which may be determined the exact area of each held within the parcel.

Aerial Surveying and Tax Reappraisal.—The most outstanding examples of aerial surveying as applied to tax reappraisal, with which we are familiar at present, are the cases of

several cities in Connecticut where appraisals were made by a professional appraiser who carried on his studies from aerial maps. The methods used, and advantages to be gained, in these cases are not limited to municipalities alone and we feel that we are not straying from our county field when we quote some of the facts pertaining thereto.

In the city of Middletown the grand list was raised from 20½ millions to 31½ millions of dollars; 1,896 buildings were found which had not previously paid taxes. A new school and fire house were added to the budget as well as a sinking fund of $20,000 per year to retire $6,000,000 worth of railroad bonds, bought sixty years ago, on which over one million dollars in interest had been paid and not one bond retired. The tax rate was lowered from 30 mills to 24 mills.

In Manchester the grand list was raised from 35 millions to 52 millions of dollars, a new town hall was added to the budget and the tax rate lowered from 18 mills to 13 mills.

The grand list in Rocky Hill was raised from 1½ million to 4 million dollars and the tax rate lowered from 22 mills to 8¼ mills.

Quoting from the report of an appraisal engineer of a municipal service company of Connecticut, in the case of the city of New Britain: ". . . a raise in the grand list from 48 million to 94 million dollars, and the tax rate . . . decreased from $33 to $20, . . . was accomplished without an appeal to the court.

"On Main street, out of 248 stores 49 were omitted from the lists. Etc."

All of these municipalities had been trying to build roads, schools, fire houses, etc., but could not do so because the taxpayers would not allow the rate to go any higher under the old system of assessing.

Subdivision Control.—By showing the exact character of existing improvements, and the relative location of all improved lands which may be subdivided in the future, most intelligent study is afforded by the aerial map for subdivision control so that all improvements will conform to the general county plan.

Many interesting and valuable studies can be made as to the probable trend of future improvements where aerial maps may be had of a certain area as all vacant property is accurately shown relative to property improved. Careful analysis of the conditions shown—topographic, soil drainage, class of industry, and other conditions—will frequently reveal a preferential trend in a certain direction, which will enable the planning commission to plan local improvements to better advantage.

Some counties have had their forested areas mapped from the air for the purpose of preventing and combatting forest fires. This density of growth and type of timber is quickly apparent from such maps and fire fighting methods may be planned with more certainty than with information heretofore available. No doubt such maps will be utilized to lay out fire breaks in the large grain fields of the middle west as such maps have the additional advantage of affording means for accurate acreage and crop estimates.

In the preparation of this report credit is due Continental Air Map Co. and Fairchild Aerial Surveys, Inc., both of Los Angeles, for information submitted and assistance rendered.

Acknowledgment.—The foregoing is abstracted from a committee report presented Jan. 17 by Mr. Abel at the 26th Annual Convention of the American Road Builders' Association.

Interesting Oil Mix Plant Used on New Mexico Highway Construction

The tendency toward greater elimination of hand labor in highway building is again demonstrated at the oil mix plant of the New Mexico Construction Co., who have the contract for the Roswell-Dexter oil job.

This plant is run by electricity in its main parts, with gas and steam as power givers for the subsidiary units. The clamshell bucket used for dredging up the gravel out of the pit before treatment is operated by gasoline and is movable, being mounted on a large truck. The rock crusher and drying unit is powered by electricity. The separator which separates coarse gravel from the fine material which binds the mass is electrically operated.

From the separator the material drops into two separate piles which are directly over chutes leading into an underground compartment. Here a man stands and by the simple manipulation of two levers proportions the materials by an automatic weighing bin which drops the correctly combined rock and sand onto an electrically operated conveyor, which carries them to the mixer.

The mixer, a pug mill machine, mixes the two parts of earthy material with hot oil, which is pumped in by a motor pump and weighed by an automatic weighing machine. The mixer then dumps its load into the waiting trucks, which carry it to the road, where it is dumped again by power and later spread by power maintainers. From first to last not a bit of hand labor is put on the material.

A new feature is the effort to make working conditions comfortable to the men employed. In the underground compartment an ingenious machine has been rigged up which makes a constant circulation of fresh, cool air available to the man employed at the weighing bin. Electric fans draw the air in one compartment, swirl it around the man's head, then expel it.

Troublesome Road Problem in Areas About Large Cities

Co-ordination and co-operation of authorities in charge of local roads and highways in areas adjacent to large cities is needed, according to the Bureau of Public Roads of the United States Department of Agriculture.

There are approximately 2,750,000 miles of local rural roads in the United States, and approximately 1,000,000 miles are administered by town or township authorities, and 1,750,000 miles are administered by county authorities. There are 3,066 counties or equivalent subdivisions, of which 67 in the New England states have no relation to improvement or maintenance of roads. Authorities of the remaining 2,999 exercise jurisdiction over the 1,750,000 miles of local roads classified as county roads.

Only 975 of the 2,999 counties have control over construction and maintenance which may be described as reasonably competent, according to the bureau, and there are 829 counties which have no definite organization whatever for the maintenance of roads, and in which the work is of the most casual and inefficient nature.

"The county or township unit is generally so small and its taxing power so limited," say these Federal road authorities, "as to preclude overhead costs for proper supervision of and equipment for road work. If adequate equipment is provided, the area is generally so small, and the mileage so limited that it can not be employed full time.

"In many counties control is limited to a single engineer who, in many cases, is poorly paid and is inexperienced or relatively incompetent. Only the larger or richer counties have sufficient income to employ competent engineers. Also elective local authorities seldom have the qualifications necessary for highway administration. There is a tendency for them to permit consideration other than the requirements of traffic and other properly controlling conditions to influence their administration.

"The outward movement of population in metropolitan areas has caused a rapid growth of suburban sections. Generally, each of these urban units has partial jurisdiction over sections of the county highways within its borders, and the lack of a common plan has been a serious obstacle to continuous and consistent improvement of main highways. This condition, coupled with the rapid increase in traffic has resulted in serious congestion."

In these areas, says the bureau, land values are higher and with the concentration of population more and better highways can be supported.

Clearing Grubbing

Cost on Highway Job in California

By M. H. HUBBS
Resident Engineer, Division of Highways, California Department of Public Works

THE completion of the Hauser and Englehart contracts, from Orick, Humboldt County, to the Del Norte County line, eliminates 15 miles of rough, winding road through dense redwood forests and cuts one hour from the driving time between Eureka and Crescent City.

A 24-ft. crown width road, increased to 30-ft. crown width in the low country, surfaced with crushed gravel 20 ft. wide, was constructed at a cost, including the heavy clearing, of approximately $600,000.

The Englehart Paving & Construction Co. was awarded the contract for clearing and grubbing the 15-mile project, consisting of 65 acres of trees, stumps and down logs which were larger than 12 in. in diameter.

All trees, stumps and logs under 12 in. in diameter were included in the grading contracts, which were awarded to W. H. Hauser, Oakland, Cal., from Orick to Russ Grove, 8.5 miles, and the Englehart Paving and Construction Company, Eureka, Cal., from Russ Grove to the Del Norte County line, 6.5 miles.

Clearing Operations.—Practically all of the project lay in dense redwood forests almost impenetrable, with immense down logs, heavy underbrush and redwood trees up to 14 ft. in diameter.

The falling of these large trees, the blasting of the stumps and the removal from the construction limits was a problem made more difficult by the litter of down logs, some of which had lain for hundreds of years partly buried, while trees 6 ft. in diameter had grown on top of them.

The falling was done by 16 choppers working in sets of two to each tree. The choppers were followed by the buckers, or sawyers with drag saws, who cut the logs into merchantable lengths suitable for handling. The buckers were followed by the powder men, who blasted the stumps. The logs and stumps were then removed by the blocking crew.

Costs.—Six months were required by four crews of blockers, 10 men per crew, to complete the removal of 1,900 trees from 65 acres.

Each crew was made up as follows:

Blocking:
- 1 9x11 spool donkey (steam).
- 1 Donkey operator.
- 1 Spool tender.
- 2 Riggers.
- 4 Hook tenders.
- 1 Wood buck.
- 1 Water buck.

Falling:
- 16 Choppers.
- Bucking up.
- 4 Sawyers.
- 2 Drag saws.

Stumping:
- 1 Powder man.
- 7 Helpers.

Clearing cost, including material and equipment:

Falling	$ 9,250
Bucking up	5,658
Stumping	18,974
Blocking	50,122
Total cost	$84,004

The average total cost per acre was $1,292.37.

The average cost per tree was $45.15, or $7.11 per thousand board feet of standing timber.

The number of trees separated into sizes and their average approximate cost per tree is as follows:

				Average cost per tree
486 trees	12 in.	to 20 in.	diameter	$ 16.65
416 trees	21 in.	to 30 in.	diameter	26.35
288 trees	31 in.	to 40 in.	diameter	38.10
328 trees	41 in.	to 60 in.	diameter	52.85
124 trees	61 in.	to 80 in.	diameter	74.30
118 trees	81 in.	to 100 in.	diameter	93.70
101 trees	101 in.	to 220 in.	diameter	171.65

1—The Old Road. 2—Clearing the Way for the New Highway. 3—Mammoth Stumps That Were Removed. 4—The New Highway

Forty tons of powder were used in blasting the stumps at an average cost of $6.45 per stump, or an average of 15 ct. per inch diameter of tree.

Many of these stumps were from 10 to 20 ft. in diameter at the ground.

Grading.—The material on the northern half of this project (The Englehart Contract), contained clay, which, due to continuous fogs, never completely dried out, and the contractor was confronted with the problem of hauling the material away from his shovels over practically impassable roads.

Five-yard dump trucks were quickly discarded as too heavy. Ford 1½-yd. trucks were used with some success, but they quickly cut ruts, requiring continuous maintenance in order to haul at all.

Fordson 1½-yd. iron mules were then used and proved very successful. The wide wheels ironed out the spongy subgrade and little maintenance work was necessary. Four of these iron mules were sufficient to keep one shovel going, hauling from 300 to 1,000 ft. and handling from 300 to 350 cu. yd. per shift.

Surfacing.—Rain falls in this part of Humboldt County 11 months out of 12, making the construction of a suitable subgrade a difficult and expensive problem. Heavy fogs kept the subgrade in a wet condition between showers. In some cases suitable material for decking was obtained for placing on the worst places, but this decking material was scarce, and as a rule it was a matter of fighting the mud. Surfacing operations were suspended for five months during the winter.

Underground water was encountered on the northern portion and the subgrade at these places was drained by tile drain placed at the side of the road, parallel to center line and 3 ft. below the subgrade. About 4,000 ft. of 6-in. tile drain was placed.

Cost of Handling Traffic During Construction.—One of the most important problems involved was that of "carrying traffic through construction without interruption."

While traffic is much heavier on many other highways throughout the state, few, if any, suffered the congestion which occurred on this 15-mile stretch of one-way road, with widely separated turnouts and frequently blocked by construction operations. Four hundred to five hundred machines was the daily average during the months of June, July and August, requiring a force of seven traffic officers.

These men were appointed by the Motor Vehicle Department but worked under the supervision of the resident engineer.

Two strings of cars, each in charge of two traffic officers, left each end of the job simultaneously, passing at a designated point about half way. Two officers acted as flagmen at each end and the seventh patrolled the road directing and giving assistance to such

stragglers as had dropped out of the line on account of tire or motor trouble.

Dust at times became bothersome to the drivers in the long strings of machines and it became necessary to sprinkle the road, which required two water wagons 8 hours per day each. Long lines of machines cut the road up badly, which made frequent blading necessary.

The cost of handling traffic, including this maintenance work, was $13,200, or about 3½ ct. per cubic yard of excavation, and about 10 ct. for each car conducted through the work during the existence of the control system.

Acknowledgment.—The foregoing is taken from the November-December issue of California Highways and Public Works, the Official Journal of the Division of Highways, Department of Public Works of the state of California.

Asphaltic Surface Treatment in Tennessee

Relation Between Specifications and Results

By J. E. MORELAND

State Construction Engineer, Tennessee Department of Highways and Public Works

The asphaltic oil used for surface treatment in Tennessee is known as Bituminous Oil No. 2, and is identical with the oil known as O. C. 5, in Virginia Specifications. This was selected by Tennessee because it was being used and manufactured in large quantities at the time work was started. It is a cut back asphalt suitable for cold application, and has been used in that way in Tennessee.

After this specification was adopted, the Tennessee Department found it necessary to study the nature of the materials more closely, and some of the results of the study are given here.

Specifications and Performance. — This paper is written for the benefit of a large number of field engineers who, like myself, have been working with surface treatment but have been so busy with this and other work that they have had little opportunity to study specifications and processes of manufacture. Many of us have recognized satisfactory materials only by their performances on the road and have felt that specifications were more or less creations of some testing engineer and have turned the page rather quickly when the asphalt specifications were reached. This was my own experience until my duties with the Tennessee Highway Department made it necessary for me to have very close contact with the testing laboratory of the department, when I began to find that many of the clauses in specifications could be interpreted directly in terms of results on the roads. I have also had the privilege of discussing materials and specifications with some of the best known chemists in the asphalt industry, and I now feel justified in attempting to explain to field engineers the direct connection between specifications and performance on the road.

In view of the limited time I have, it is advisable to confine these remarks to surface treatment materials, and within this class to cut back asphalt. The first requirement for a cut back is that the base shall be an asphalt of the desired penetration. In the customary form of specification, there is usually a requirement showing the amount of loss in heating the material at a temperature of 163 degrees Centigrade for five hours, after which the penetration of the residue at 25 degrees Centigrade is specified. This penetration is a guide to the character of the asphalt which forms the base of the material.

Asphalt Grades for Bases.—At a recent conference of representatives of several Southern states with the representatives of asphalt producers, it was brought out that the two grades of asphalt which are favored for use as bases are those having penetration from 85 to 100 and from 150 to 200. The first of these materials will be recognized as the customary asphalt for bituminous macadam. The selection between these two types of base will depend on the type of road bed to be treated and the kind of treatment to be made. The base material must be cut back with a solvent which will make it liquid at a desired temperature. This is insured by specifying the specific viscosity which experience has shown to be necessary for the desired results and also by specifying the total amount of distillate.

In general the viscosity is the guide which is the most easily followed by the field engineer, but the amount of distillate, of course, must correspond to the viscosity. If it is desired to use the material for printing the surface of the road, it will be found that material of a low viscosity (10 to 20 Engler) will give the best results, while for seal coats, higher values up to 35 for cold applications are satisfactory. The Furol apparatus for determining viscosity is preferred by many chemists in place of the Engler, and the values given by this apparatus are approximately four times those of the Engler for the same material.

Requirements for Solvent.—The first requirement for the solvent, or naphtha, is that it shall be an efficient solvent, or in other words, that all, or practically all of the naphtha shall be capable of dissolving asphalt and holding it in solution. There are two reasons for this: First, that it is expensive to buy and pay freight on useless materials, and the other is that the value of the material as a primer is decreased if a part of the liquid which soaks into the road surface carries no asphalt with it. In general, the heavier grades of naphtha are better from this standpoint, as they are more efficient solvents, provided they are not heavy enough to contain excessive oils. These heavier grades are not always desirable as they cause the material to be slow setting.

Specification Requirements That Should Be Studied.—The items in the specifications which should be studied to determine the qualities of a naphtha are the total distillate requirements at temperatures of approximately 302 degrees Fahrenheit and 392 degrees Fahrenheit, and the end joint of the naphtha. There are other requirements in the average specifications, all of which have a meaning, but these are the ones which are of most interest to the field engineer, as they can be interpreted most quickly in terms of results on the road.

Some of the other requirements in the average specifications, are for safety and others serve as a check on the ones which have been described. A serious effort is being made at the present to standardize the materials which are combined to form the cut back materials and if possible, to limit the number of materials which are made from these ingredients. It is hoped that this will be successful for the reason that it will enable the material to be produced economically, and will also tend to prevent delays in shipment, which have formerly been caused by variations in requirements from different states. If this effort at standardization is successful, it may soon be possible to buy cut back asphalts with no more uncertainty and delay than we now buy white lead and linseed oil, which are more or less standardized. Even though this may happen, it will still be advisable for the engineers dealing in bituminous materials, either cut back or asphaltic cements, to know some of the principles which govern the behavior of the materials when they are used in construction.

From my own experience, I feel sure that any construction or maintenance engineer will be amply repaid for his trouble if he will make the acquantance of his testing laboratory and will fix in his own mind the relation between specifications and results. This is one of the ways we have secured service from bituminous materials in Tennessee and I feel that no other work has been more important from the service standpoint than the study we have made of bituminous material.

Acknowledgment.—The above paper was presented at the 7th Annual Asphalt Paving Conference held at New Orleans, La., Dec. 3-7.

Financing County Highways

A Summary of General Practice

By JOHN J. McHUGH
Deputy Clerk, Hudson County Freeholders, Jersey City, N. J.

WITH a view to ascertaining the methods now in vogue at various sections of the United States, a series of nine questions was submitted to 125 county officials in the 48 states who had indicated interest in this subject.

Forty-one of the 125 questioned made replies. These 41 counties were from 25 different states.

The questions asked were simple but they were particularly pertinent to county financing. The replies showed such wide divergence in practice and principle that a brief summary will be given.

Summary of Replies.—These replies may be considered as typical of the country at large.

Twenty per cent had no system of fiscal accounting, while the remainder, or eighty per cent, had such a system. The descriptions of these systems showed an entire lack of uniformity as between individual counties.

Seventeen per cent had no system of cost accounting. Eighty per cent had such a system and three per cent did not reply. Those who had a cost accounting system gave descriptions of their systems, which showed an entire lack of uniformity.

The questions on the methods of financing county highways and the sources of revenue showed more uniformity than the cost accounting methods. Ninety per cent replied that their revenues were obtained either by direct or indirect taxation.

These 41 counties were asked what they considered the best method of financing county highways. Twenty-seven per cent favored bond issues, 44 per cent favored taxes, 24 per cent favored a gasoline tax and 5 per cent made no reply.

As between the bond issue system and the pay-as-you-go system, 70 per cent favored the pay-as-you-go system of financing and 30 per cent the bond issue method.

The budget system for allocating county highway funds was popular and the reasons were adequate. Eighty-eight per cent favored this system, 5 per cent did not favor that budget system and seven per cent made no replies.

The question as to what financial methods had been found valuable in preventing waste and for increasing public confidence brought forth many interesting replies. All of these replies cannot be repeated here but they included such direct information as "Be Careful," "Keep Free of Graft," and, last but not least, the "Need of Organization" was stressed.

Organization the Keynote.—It must be apparent that even a casual study of the summary shows a wide divergence of opinion. It would seem that the last suggestion noted: i. e. "need of organization" is the keynote to the whole situation. It has been well said that "Men are creatures of their environments." In this instance, it seems that public officials are subject to local conditions. If the majority of the taxpayers of any county are not "sold" on the need of first class county highways, or, if admitting such need, are not willing to pay for them, then the task of the county officials is a discouraging one. That is, unless they are willing to begin the campaign of education favoring better county highways.

Under existing conditions it would be obviously ridiculous to offer any suggestions as the "last word" in county highway financing. Assuming that there are a sufficient number of county officials, in the various states, who desire the adoption of modern methods of financing county highway construction and maintenance, the following suggestions are offered for their consideration.

Securing Legislative Authority.—First, perfect a state wide organization of all county officials, who are in any way connected with responsibility for the county highways. Be sure to include the legal branch. With few exceptions, if any, state laws govern the mode of procedure to be followed by county officials.

That being so, it follows if there are to be betterments, or changes, in county procedure, the county officials must work in harmony with the state legislature. This can best be accomplished by holding weekly meetings of the state association of county officials, at the capitol, during the sessions of the legislature. If possible, have at least one representative, well versed man from each county to attend all meetings. If that be impossible divide the state into districts, each with an equal number of counties. Have the counties in each district elect a member to represent them on the executive committee. Make a thorough study—through the legal branch—of all existing laws. Decide upon the necessary changes and prepare the bills for introduction in the legislature. Do nothing secretly. Arrange for the fullest public discussion. Present your case to the members of the legislature. Interest the Governor. But, above all else, confine all of your activities to purely county matters. Once the members of the legislature have been convinced that there are no ulterior motives, particularly as regards financing, back of the plans of the association, a common ground can be easily found for the composing of all differences of opinion. A broad statement. But that has been the experience in some states; why not in all?

In addition to securing the necessary legislative — or statutory — authority, the state association of county officials can agree upon the best plan, or plans, of financing county highways, by frequent consultation. As a basis for discussion, the following fundamentals are offered.

Permanent highway construction should be a capital expenditure. That is usually provided for by a bond issue. On the other hand highway maintenance should be provided for from current revenues, to wit—taxes, direct or indirect.

Bond Issues for Permanent Construction.—Bond issues for permanent construction are advocated because such construction is for future as well as current use. Therefore, the whole burden of cost should not be placed on present day taxpayers. The cost of roads reconstructed or rebuilt, of a permanent type, should also be provided for by the issue of bonds. On the other hand ordinary maintenance should be provided for as a current expense for present day use, and provided for in the annual budget of appropriations.

There are some who advocate a direct improvement tax upon abutting land for county highway construction. In the instances of extraordinary benefits this would seem to be justified. On the other hand, if there are state, county or municipal taxes levied on the same lands, there looms the charge of double taxation. Some states so arrange tax collections that state and county taxes added to the local tax bill and all collected through the local tax collector.

If there is a continuous source of revenue, through taxation, this may be capitalized for bond issue purposes. It must be obvious that a much greater amount of construction can be provided for under the capital or bond issue plan that under any pay-as-you-go method. However, it is possible to have a modification of both. Instead of long term bonds, limit the latter to short terms, predicated upon the probable life of the improvement, and issue in serials instead of for a fixed period of years. This will save interest and avoid any possibility of misuse of sinking funds.

There should be a fool proof fiscal accounting system established in every county government. Likewise, where the income is assured, there should be an annual budget. In short, everything possible should be set up as a safeguard of public funds and the begetting of the fullest possible public confidence.

Counties and Gas Tax Receipts.—Counties should make every effort to share in the receipts from the tax on gasoline. Note has been made of the fact that in some states part of this tax is being used for other than highway purposes. The gasoline tax is essentially on the basis of the "user pays." In other words, motorists are paying for the use of improved public

highways. When this revenue is diverted to other than highway purposes it would seem that the county officials have an opportunity to awaken public sentiment to the injustice of the practice. Such an argument should have an especially strong public appeal in states where the proper development of county highways are suffering for lack of sufficient funds.

In some states the revenues from motor vehicles, both licenses for the automobiles and drivers, plus the gasoline tax are all collected by the state. Then a generous share is allotted to the counties on the basis of population, property valuation and road mileage. Other states share with the counties on a different basis. Some states collect the gasoline tax from the dealers at considerable cost. Others, from the distributors at very small cost. In the latter there is, or should be, greater margin for the counties.

Revenue from Motor Busses.—There is another source of revenue available for the counties, which it is doubtful has been given much, if any, consideration. Motor busses are using county highways to a greater extent every year. In many of the states there are laws providing that cities may collect a franchise tax of five or more per centum of the gross receipts of these public transport vehicles. This is on the theory of wear and tear on the city streets. If that be sound, and it has been in vogue for many years, why not a revenue from the same source for wear and tear on the county roads? Here would seem to be an excellent opportunity for some constructive thinking. Some states have gone so far as to levy a tax on interstate busses. Are not the counties losing a considerable amount of revenue to which they are justly entitled?

With the well nigh universal use of the automobile, the question of good roads should be one of paramount interest to every citizen. None of the latter expect something for nothing. On the other hand, they have every right to expect good roads when they pay for them. If the right sort of officials will organize, as previously suggested, so that the whole truth may be told the public, or the taxpaying part thereof; there should soon be an end of the problem of county highway financing. As was said at the outset, organization is the keynote to the whole situation.

The foregoing is submitted for wide open discussion. With a view to leaving all interested in this subject, the greatest possible freedom in expressing their reactions, the committee has refrained from making specific recommendations.

Those who desire to make progress toward the solution of the question of the best methods of county highway financing are cordially invited to give others the benefit of their opinions. Don't be afraid to say what you think. You may have the "live thought" needed to make this discussion an emphatic success. Let's have it. Talk out.

Acknowledgment.—The foregoing is taken from a committee report presented Jan. 17 at the 26th Annual Convention of the American Road Builders Association.

The 1929 Road Show

With exhibits valued at $5,000,000 and a registered attendance of over 20,000 the 1929 Road Show of the American Road Builders' Association was a most decided success.

The chief points of interest noted at the Road Show this year were the development of machines for mixing concrete in transit and for keeping mixed concrete agitated in transit; the trend of shovel and crane power away from steam to gasoline and diesel; trend toward automatic type of equipment, i. e., adjustments, machined surfaces, roller and ball bearings, enclosed gearing, etc.; number of independent manufacturers of equipment, especially power shovels; increase in number of exhibitors; development of Pan-American division and Pan-American interest in our road building methods and equipment; meager attendance at convention sessions; and the multiplicity of new inventions.

The show, which in the earlier phases of the development of the American Road Builders' Association was an accessory to the convention, has in the later phases become of greater interest than the convention sessions. It has become a case of the tail wagging the dog. About 500 carloads of machinery were on display. It has been stated that $5,000,000 would not purchase the equipment shown. Massive, yet trim, pieces of machinery rested in the national exhibition at Cleveland mutely revealing the purpose of the occasion.

From all corners of the United States county and city officials, engineers and state highway leaders, contractors, manufacturers and equipment distributors gathered at one of the largest of these annual conventions and shows. They listened to the newest experiences of men who knew the road business, and gazed at the latest contrivances for smoothing the way of the motorist. There is not a single progressive community in this country that will not in some way be benefited by what was seen and heard in Cleveland.

New York and Chicago recently witnessed the New Year's first automobile shows, at which were presented the world's greatest collection of cars, cars more beautiful than ever, but of larger importance, cars that are finer mechanically than ever before, and cheaper.

These two exhibitions present a striking contrast; the one composed of colorful beauty that all the wealth of Croesus could not have produced; the other, drab as far as color is concerned, embracing great lumps of iron and steel formed into concrete paving mixers, tractors, power shovels with hungry jaws, having about them an air of capability which acclaims that His Majesty, John Motorist, will have attention.

The Cleveland display calls to mind that only a few years ago road improvement programs depended in no small measure upon the limited number of contractors whose equipment would permit them to build but a few miles of pavement in a season. Nowadays road building is a great industry with contractors everywhere ready to do well the public's bidding. It is today more a matter of the state providing work than it is of fitting road programs to road builders' equipment.

Now is the time of year when the public and its official representatives should be making actual plans for the road building season just ahead. Funds must be made available and contracts must be let, so that the road building army may get to work as soon as the frost is out of the ground and excess water drained away.

Better automobiles demand better roads.

There is one regret, however, that throws a dampening effect on the wonderful display. It is this: Out of that surging crowd, which pushed itself among the exhibits, but a small percentage attended the primary meetings of the whole affair, the convention sessions. This fact stood out very prominently.

Oak Trees Favored for Roadside

Oak trees, of which there are species native to nearly all parts of the country, are more generally used for roadside planting than any other kind of tree, says the Bureau of Public Roads of the United States Department of Agriculture.

Maples are next in importance for a large part of the country, but as the most used species are not well adapted for the purpose, the selection must be carefully made.

For the cooler dry regions the most promising trees are the green ash, common locust, hackberry, thornless honey-locust, and poplars, with box-elder, willows and poplars for the extremes of cold and drought.

In warm, dry climates the eucalyptus, or gums, the palms, the Jerusalem thorn, and the mesquite are good.

Only thrifty, vigorous trees, with healthy foliage, look well on country roads. To secure this type for any location it is usually best to select native varieties, although trees from localities with similar growing conditions are frequently satisfactory.

Excavating by "Trapping" Method

"Swede" Tunnel Plan for California Road Job

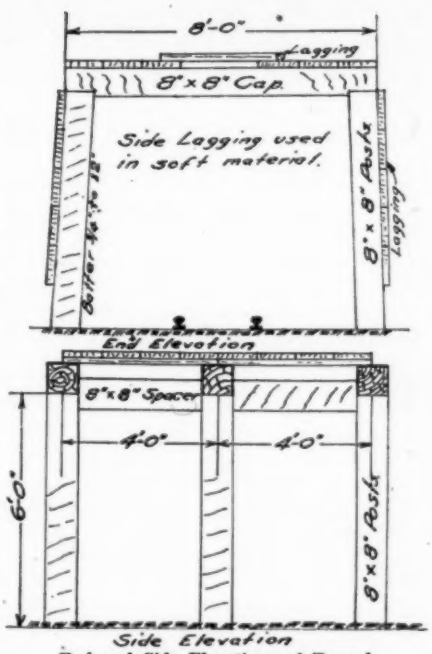
THE "Swede" tunnel method of excavating was used in the construction of a new highway between Greenhorn Mine and Buckhorn Summit in California. The work was described in the November-December issue of California Highways and Public Works by B. H. Henry, Superintendent of Convict Camp No. 12. We are indebted to the above mentioned publication and to Mr. Henry for additional information for our article

At the time operations were started on this road there was a company of approximately 120 San Quentin convicts employed.

Equipment being limited and having only one 1¼-yd. gas shovel, it was decided to handle the moving of material, which in most places consists of decomposed granite, by a less expensive method than by hand.

Tunneling and Trapping Method.—The method decided upon was by tunneling and trapping, the method being sometimes known as by Swede tunnel; therefore, tunnels were constructed in the manner used by miners, namely timbering with lagging and caps, a trap being placed in the roof of the tunnel, through which the muck was run into Swede cars, which were pushed and dumped by man power, a track having been placed from within the tunnel to the end of the fill to be made. See Fig. 1. Very gratifying results were obtained by this method. Where the grades were steeper and the hauls longer, a horse was used for propelling the cars.

Figure 2 shows a cut being put through by this method, and shows where the muck has slid down to the top of the trap, which it readily does, especially in dry weather, when it runs like sugar. The material is loosened with very light shots, to avoid possible damage to the tunnel, and also bringing down too much material at one time.



End and Side Elevations of Tunnel

Figure 3 shows the men at work pulling down material and keeping it running down to the trap; sloping is done at the same time.

Figure 4 shows a cut, half of which has been removed by the trap method, the tunnel timbers and trap from this work having been salvaged for use in a tunnel which is being driven in from the opposite end of this cut. When the work from the opposite end meets the work shown in the picture, the cut will be complete except for a small amount of clean up work which will be handled with a power shovel. Generally speaking, the slopes will be completed to within approximately 15 ft. of grade, and this material near the bottom of the cut, that has to be handled with a shovel, only amounts to from three to nine yards per foot.

Cost Data.—Following are some interesting facts relative to the tunneling and trapping methods, which will show the relative cost of operations per cubic yard of material moved, which covers the cutting and handling of lagging and timbers, cost of driving tunnel, and cost of trapping operations for one of the cuts put through on this job.

The tunneling and trapping system was first inaugurated about March 1, 1928, and there have been about four crews of approximately nine men to the crew at this work since that date, with an average of about 12½ cu. yd. per man-day.

The quantity of powder used in connection with this operation averages about one-quarter pound to the cubic yard of material.

Cutting and Handling of Logging and Timbers, 129.5 Lin. Ft. Tunnel

Free labor	.....
Convict labor	$92.40
Equipment	.....
Gas and oil	.....
Material	.....
Total cost	$92.40
Unit cost	$0.713

Driving Tunnel 129.5 Lin. Ft.

Free labor	$25.63
Convict labor	189.00
Equipment	16.50
Gas and oil	1.65
Material	36.68
Total cost	$269.46
Unit cost	$2.08
Total cost of driving tunnel per lineal foot	$2.793

Trapping 13,620 Cu. Yd.

Free labor	$325.12
Convict labor	2,281.67
Equipment	28.86
Gas and oil	15.34
Material	567.76
Total cost	$3,218.75
Unit cost	$0.2628
Actual cost	$0.2628
Overhead	0.058
Inventory	0.015
Distributable	0.045
Total cost (per cubic yard)	$0.3808

It will be noted from the above table that the cost of procuring lagging and timbers for tunnels was a matter of convict labor. This was paid for at a rate of $2.10 per day. This rate is set by the state and applies to all convict work on road construction.

The item of free labor covers the wages of foreman which in this case amounts to $6.00 per day. The equipment used in hauling material for driving tunnels consisted of part time of Best 30 Tractor at a daily rental of $6.00 and part time of Crevrolet truck at $3.50 per day. The gas and oil costs on the job were 20 ct. for gasoline and 32 ct. for oil.

The item of material covered such items as shovels, picks and like tools required to carry on.

Inventory in this case consisted of preliminary work done before pay quantities had been estimated by the engineer and which were written off as the work proceeded on a basis of estimated yardage.

The item of overhead was the general expense incurred for the job as a whole and which is prorated out each month on a pay quantity basis, as shown by the engineer's estimate.

Distributable items consisted of such items as camp construction, moving camp, etc., and were written off each month on the same basis as excavation inventory refered to above.

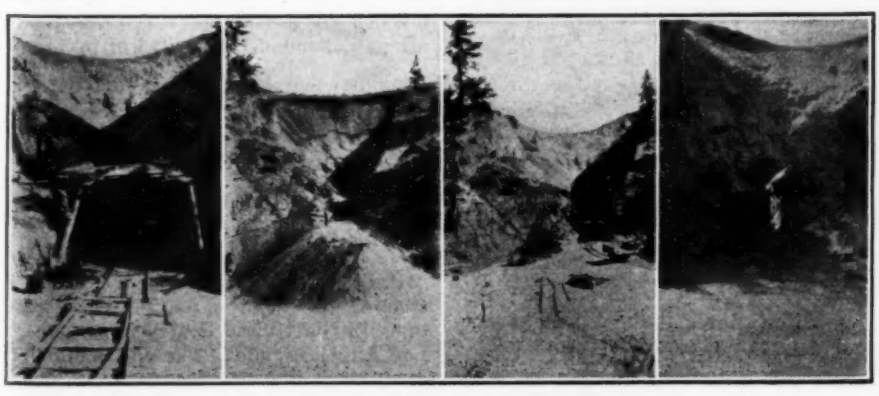


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Highway Financing

Some Needed Readjustments

By W. C. MARKHAM
Executive Director, American Association of State Highway Officials

SINCE the great bulk of funds received for road building on the state highway systems come from motor license fees and gasoline tax, a comparison of receipts among the states, grouping them according to method of determining the license fee and rate of gas tax, brings out some startling facts which ought to be the basis of some definite recommendations on the part of the state highway officials to their respective legislatures.

The Gas Tax.—A little over 11 years ago the state of Oregon started something in highway financing when it established the gas tax. It began with a 1 ct. tax but the results have been so satisfactory that some states have a tax as high as 5 ct. and a 1 ct. tax is no longer the rate in any state.

States which today get the highest total receipts per car, whether in the group charging 2 ct., 3 ct., 4 ct., or 5 ct., are all from the South, where the open weather conditions enable a constant use of the car.

But there is also a wide spread between the maximum and minimum receipts per car in all of the groups. Six states have a 5 ct. tax and there is a difference of $7.00 per car between the maximum and minimum receipts. There are 12 states which have a 4 ct. tax and here there is a $11.00 difference. Fifteen states have a 3 ct. tax with a $5.00 difference and 11 states with a 2 ct. tax and yet their difference is $4.00 per car.

The average gas tax per car for the 2 ct. group is $9.63. If this were a 1 ct. tax we would naturally presume the average would be $4.81. Using this as a basis, the income would be expected to be as follows: 1 ct. rate $4.81; 2 ct. rate $9.63; 3 ct. rate $14.43; 4 ct. rate $19.24 and 5 ct. rate $24.05 but the actual average receipts for the states in each group, which collected for a full 12 months period, were: 2 ct. $9.63; 3 ct. $13.85; 4 ct. $21.34 and 5 ct. $22.43. The most striking difference is in the 5 ct. group which shows but a little over $1.00 per car gain over the 4 ct. group. This naturally raises the question as to whether a 5 ct. rate is not at the point where patronage is curtailed.

Average Gas Receipts per Motor Vehicle Arranged According to Gas Tax Rate, 1927

5-Ct. Tax—6 States

*Florida	$27.81
South Carolina	25.44
*New Mexico	23.87
Virginia	21.14
*Arkansas	21.00
Kentucky	20.70

4-Ct. Tax—12 States

Alabama	$24.26
*Georgia	23.53
Mississippi	22.42
North Carolina	20.41
Nevada	18.29
*Arizona	17.13
*Idaho	15.51
*West Virginia	15.43
*Maryland	15.38
*South Dakota	14.11
*Maine	13.98
*New Hampshire	13.20

3½-Ct. Tax—1 State

*Utah	$15.51

3-Ct. Tax—15 States

Tennessee	$15.19
Oregon	14.89
*Wyoming	14.55
Oklahoma	14.30
*Texas	14.08
*Delaware	14.05
*California	13.62
Montana	12.74
*Ohio	12.66
Indiana	12.45
*Michigan	12.34
*Colorado	11.69
*Vermont	11.38
*Pennsylvania	11.12
*Iowa	10.29

2-Ct. Tax—11 States

Louisiana	$11.89
New Jersey	11.46
Connecticut	10.85
Washington	9.93
Missouri	9.28
Nebraska	9.21
Kansas	9.15
Wisconsin	8.63
Minnesota	8.00
North Dakota	7.93
*Rhode Island	7.75

*Not full year at this rate.

Average gas tax per car for 2 ct. rates, full 12 months period, is $9.63; average for 4 ct. rate is $21.34, when at double 2 ct. would be only $19.26. Using the 2 ct. group full time, at a 1 ct. rate, would be $4.81; therefore, 2 ct. $9.63; 3 ct. $14.40 plus; 4 ct. $19.24 and 5 ct. $24.05, but the average of full time states is 2 ct. $9.63; 3 ct. $13.85; 4 ct. $21.34 and 5 ct. $22.43.

Motor Vehicle License Fee.—A comparison of the receipts from motor vehicle license fees throughout the country shows that among states using the same method or methods in determining how the fee shall be secured, there is no uniformity in schedule rates.

There are 14 states which use horsepower alone as the determining method and yet the schedules of rates are so different that the maximum amount received per motor vehicle in this group is $19.88, while the minimum is $6.84—a difference of $13.04 per vehicle.

Four states use horsepower and net weight as the factors and their receipts vary from $15.69 to $6.67.

Two states use horsepower and gross weight. The schedule of one is 25 ct. per horsepower and 25 ct. per 100 lb., while the other is 12½ ct. per horsepower and 55 ct. per 100 lb. They enter the financial hopper at different rates of speed but one comes out at $17.73 and the other at $17.72.

Six states use gross weight only and the treasury is helped $19.94 per car in one state and the least must be satisfied with $8.91.

A dozen states use net weight only and they range from $8.90 to $26.68.

Two use a flat rate and get the same income—$5.65 per car.

Just to be different seven states each have a method of their own. One uses value in pounds net weight; one, value; one, cost price; one, cubic inch displacement; one, manufacturers list price; one, net weight horsepower and times registered; and finally, one uses a combination of factory price, net weight, horsepower and times registered, and yet after all this trouble, the amount received, per car, is only $8.29.

A comparison of methods used shows that the final result is very much the same when it comes to the average cash received by each group. The way some of the schedules are "fearfully and wonderfully made" would seem to justify the conclusion that simplicity in method and schedule used, is greatly to be desired. It ought to be considered reasonable to presume that each state should have a minimum rate, and the vast majority of them do, but why should this minimum rate vary from $4.00 to $15.00?

Now that the theory of a gas tax is seemingly well entrenched as a justifiable method of securing funds for road building, and the rate is being gradually increased, there is a disposition in some localities to curtail or almost entirely eliminate the auto license fee. It might be well for these people to realize that the gas tax can reach a point where the increase will not be productive of increased total receipts and the states of the northern part of the country should realize that a license fee is a fixed amount without regard to climatic conditions.

That there is justice in the argument that, with the retention of the motor license and gas tax the motor vehicle should be exempted from personal property taxation, has been accepted by 13 states. This is a matter that should receive serious consideration by all the states. While there may be a few cars which, for a time, escape the license fee, none can escape the gas tax. It is a notorious fact, however, that the property tax, to use polite language, is very unequally administered, and in many instances is entirely ignored. Entire elimination of the property tax, which in most cases does not go for road purposes anyway, should be recommended to the states which have not already abandoned this plan of taxation.

Acknowledgment.—The above extract from the annual report presented by Mr. Markham at the recent convention of the American Association of State Highway Officials, is reprinted from December Badger Highways.

Park System of Los Angeles, Calif.—One of the most extensive park systems in the United States is owned by Los Angeles, Calif. The city has 5,072 acres of parks and spent over $1,500,000 in 1927 for park activities.

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

What News

Coming first by runner, and horse and rider, then stage-coach, steam-car, telegram, cable, down to the days of wireless and airplane, from North—East—West—South, NEWS has been eagerly watched for by a waiting world. The little world watching for the NEWS we have to give is just as eager to know of the happenings in the engineering field—how the output of the manufacturer is increasing and how the distributor is handling it. And, to be a worthy distributor of this information it must come to us from all four quarters — North — East — West — South,—how else could it be NEWS.

Wherever you are, let us tell your news to our engineering world. Anything that is of interest to the growth and welfare of your business, is of interest to us. Send your stories and pictures to The Editor, Distributor News, Gillette Publishing Co., 221 East 20th Street, Chicago.

Manufacturers and Distributors Day at the Road Show

AN experiment was started this year at the annual exposition and convention of the American Road Builders' Association at Cleveland, in the form of a pre-convention joint meeting on January 12th of the manufacturers and distributors of road building machinery, materials and equipment. For the benefit of the distributors and manufacturers who were unable to attend this meeting, a summary of the program is presented here.

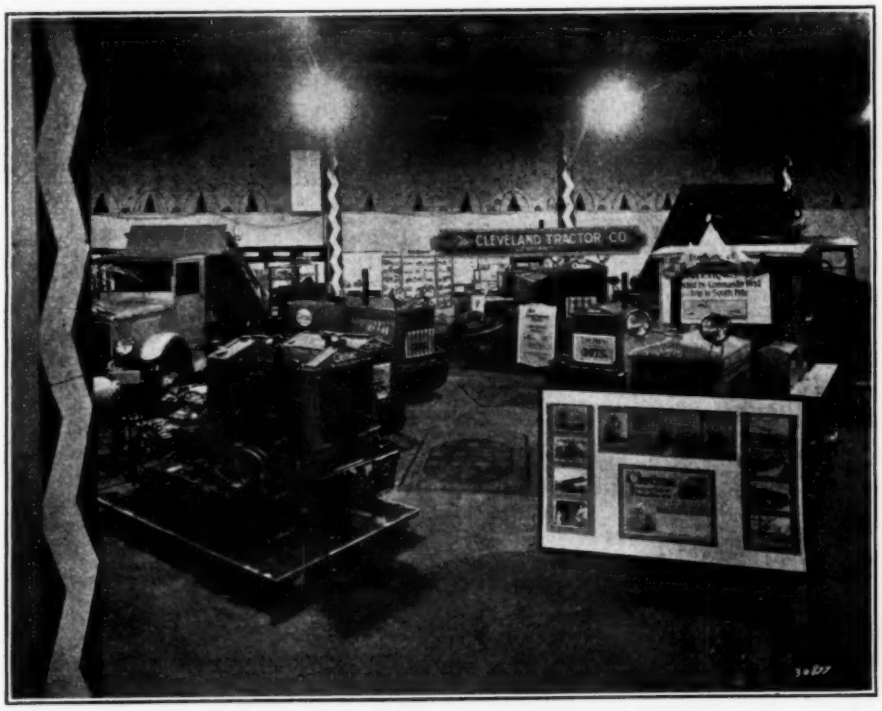
The meeting convened at 3:30 Saturday afternoon, in the Public Auditorium Music Hall, and soon after Mr. Chas. Upham, Secretary-Director of the Road Builders' Association, called for a showing of hands to see the proportion of distributors present. A favorable showing was made, which evidently pleased Mr. Upham. (According to our information, 2,500 distributors were registered at the convention, a great showing for this branch of the industry.)

"Highway Development in Foreign Countries" was the subject of Mr. Frank B. Curran's talk. Mr. Curran is a specialist in the automotive division of the U. S. Department of Commerce. In his short informative speech Mr. Curran stressed the fact that foreign attaches were clamoring for information and data on road construction. He outlined, roughly, the magnitude of the foreign field and emphasized the necessity of group action for obtaining results.

"No new country can reach its full development, no older one can continue to progress, without adequate means of land communication, of which highways are the most important," said Mr. Curran. "Airports, railroads, ocean, river and canal lines are all served to some extent by highways, as every passenger or piece of merchandise in transit must travel some part of the journey by road."

Continuing, he said that to study properly the markets of the world, a knowledge of highway development is necessary and highway statistics should be studied. This phase of economic development abroad has been inadequate, and Mr. Curran presented a table showing comparisons of road mileage in relation to area and number of automotive vehicles. He believes, as a measure of highway development, the fairest possible basis of comparison seems to be the proportion of road mileage to area. Land cannot be used most efficiently or to its fullest extent unless it has an adequate transportation system by which its people and its products can be moved from place to place at will. The number of miles of highway within a certain area, therefore, may be not only a true measure of that area's transportation system but a fairly accurate index of its social and economic development.

Using this measure of comparison, Mr. Curran pointed out that the older European countries lead, Northern Ireland having a mile of highway to every four-tenths of a mile of area, or two and a half miles of highway to every square mile. Outside of Europe the United States leads with a mile of road to 1.01 square miles. If the highway development of Northern Ireland were to be accepted as the standard that all countries should try to reach, then, said Mr. Curran, the conclusion must be that the road building of the world has begun. In the table presented by Mr. Curran the total area of the countries listed was 50,650,450 square miles. This area raised to the standard of



At the Road Show

View of the exhibit of The Cleveland Tractor Company as arranged for the annual Road Show at Cleveland. Many interesting features are noted in this exhibit. In foreground at right is duplicate of Model "40" Cletrac taken by Commander Byrd on his South Pole Expedition. Across the back of the exhibit stretched a display board for photographs and statistics, and in the center of the exhibit at the back was a hexagon shaped, revolving display case giving a panorama view of Cletracs "on the job."

Northern Ireland (two and a half miles of road to each square mile), the total would reach the astounding figure of 126,568,625 miles of highways, or over nineteen times the present total. Designed to reach the present standard of the United States (a mile of road to 1.01 square miles), it would mean the construction of more than 43,500,000 miles and the raising of the world's total above 50,000,000 miles of road. Mr. Curran does not see, at this time, any probability of such a road expansion, but he does believe that in the new and largely undeveloped regions of South America, Australia, Siberia and China great mileage of roads will eventually have to be constructed. If only one-fifth of the mileage suggested, or 10,000,000 miles, were to be constructed at an average cost of $10,000 a mile (and this is a low estimate, probably providing for graded and drained gravel roads only), the expenditure would be $100,000,000,000.

After presenting these staggering construction figures, Mr. Curran discussed the justification of great expenditures and per capita taxes necessary to raise such sums; and then touched upon the effect such improvements would have upon trade. At this time the United States is far in advance of the rest of the world in total highway mileage, and the United States and its North and South American neighbors have over 54 per cent of the world's roads, and 46 per cent of the world total can be found between the Rio Grande and the Canadian border.

The table of statistics used by Mr. Curran in his talk regarding the relation of population to road mileage was collected by the highways section of the automotive division of the Bureau of Foreign and Domestic Commerce, and is available to anyone interested.

Mr. A. P. Robinson of the Ransome Concrete Machinery Company related the benefits to the consumer, the American Public, and to the manufacturers through group action of creating standard specifications, sizes and methods of rating, relative to their products. Mr. Robinson is chairman of the mixer bureau of the A. G. C. He stated that the income comes from the public, eventually. Hence, the work of this bureau should be an attempt to please the public. One point brought out was a statement to the effect that the name plate of the A. G. C. is practically an insurance that the mixer is substantial and good construction.

Mixer manufacturers have been approached numerous times to build larger mixers. In answer to this request, Mr. Robinson asks the question, "Are we standing in the way of progress?" He answered the question by showing the operation of the vicious cycle—how one manufacturer continually tries to outdo his competitor, which results in enormous investments and rapidly increasing obsolescence in machinery.

When Mr. Upham spoke, he recited the development of the Road Show from the time it was organized 26 years ago. This year, he stated, there were approximately 500 carloads of machinery in the exposition buildings. The conventions have been improved considerably, he felt, by having all papers analyzed and read by a committee before presentation. Papers are then returned to writers for revision, if necessary. Two special committees were appointed by the association the past season, on which outstanding engineers were employed. These were a committee on highway finance and one on subgrades and pavement bases.

How Sullivan Looked at the Road Show

In the foreground the Sullivan drill sharpener and drill steel furnace, demonstrating the hammer-method of forging drill bits and drill shanks for rock drills. At the right is the demonstrator's block of concrete for drills and concrete busters, and just beyond that is the Sullivan pavement breaking core drill.

Mr. Richard Hopkins, a director of the association, presented a short paper on the accomplishments of the A. G. C. Sound finance in selling road building equipment was the seed of his talk. When a contractor should pay cash for his equipment and the manufacturer should receive, and should insist upon receiving cash, and when the serial note plan should be permissible and advisable from both the contractor's and manufacturer's viewpoint were important points discussed.

Mr. Hopkins enumerated three things to which a highway engineer is entitled when he lets a road job: "1. A job built according to his specifications. 2. A job that is finished on time. 3. A minimum of grief, annoyance and supervision during construction." Frequently the delay in finishing a short stretch of trunk line on time will make inefficient transportation on as much as 100 miles of an important route. No highway engineer likes to see a contractor start a job inadequately or inefficiently equipped, and if a piece of equipment has to be reclaimed by the manufacturer due to non-payment of serial notes while the equipment is needed on the job, it hurts the contractor, the engineer and the public.

Mr. Hopkins stated that a contractor is generally justified in buying the average piece of large equipment when the saving on one or two jobs will pay for the machine. Small equipment, he contended, below $2,000 or $3,000, should be cash in sixty or ninety days. The equipment should be suited to the particular job, and the salesman should render not only good engineering advice, but also good financial advice, and should neither oversell nor undersell.

In closing, Mr. Hopkins said that a man whose capacity is a two or three mile job should be discouraged from trying a six or eight mile job, and the engineer who lets a contract to a man whose finances are not adequate to handle the job, or the manufacturer who sells him equipment on the serial note plan is not aiding the cause of sound highway finance. Conferences of all interests are now being held to agree upon what constitutes sound finance in selling equipment on the serial note plan, and Mr. Hopkins hopes to see a definite countrywide application of such agreement before another construction season starts.

Mr. S. M. Williams, manager of the engineering construction division of the A. G. C., read a paper on "Standard Credit Policies."

This paper drew some pointed discussion on trade-in practices. One of the distributors arose and suggested that it is the desire of distributors to eliminate the trade-in on pavers. Co-operation of the A. G. C. was desired on this. Another distributor said that on the re-sale of used pavers most of this equipment finds its way to the hip-pocket contractor. He then asked Mr. Williams how the fact could be reconciled that without the stopping of trade-ins the irresponsible contractor could be eliminated. This is still a much debated question with no definite agreement as to a solution.

Robert Bosch Distributors Meet in Conference

On January 7th and 8th, at the time of the Automobile Show in New York City, the distributors of the Robert Bosch Magneto Company, Inc., held their annual conference. According to a statement of Mr. H. Waker, treasurer of the company, 1928 had proved to be a banner year in the history of the organization. In addressing the meeting, Mr. Waker said that the Robert Bosch Pyro-Action Spark Plug had enjoyed the largest percentage of increase in sales, and a marked sales increase had also been shown in the Robert Bosch Super-Energy Magneto, both through retail channels and as standard equipment used by automobile manufacturers. A feature of the convention was the announcement of the addition of the Vibro-Balanced Horns to the Robert Bosch line.

Approximately a hundred territorial distributors from all parts of the country attended the conference. The meetings were held in Hotel Astor.

Universal Portland Cement Appoints New Traffic Managers

Mr. Murray B. Billings, Chicago, and Mr. Frank E. Guy, Pittsburgh, have been appointed western and eastern traffic managers, respectively, of the Universal Portland Cement Company, according to an announcement of Mr. B. F. Affleck, the president of this company, which is a subsidiary of the United States Steel Corporation.

Mr. Billings succeeds Mr. F. T. Bentley, both in the capacity mentioned and as traffic manager of the Illinois Steel Company. Mr. Bentley retired from active service last year, but up to that time had been connected with the cement company since its organization in 1906, and with subsidiaries of the steel corporation for 35 years. He will continue to serve in a consulting capacity.

Mr. Billings is a former president of and is a director of the Traffic Club of Chicago; one of the organizers and a member of the executive committee of the Midwest Shippers' Advisory Board; chairman, traffic committee, Illinois Manufacturers' Association; chairman, rate committee, Chicago Shippers' Conference Association; member, executive committee National Industrial Traffic League; member, civic and industrial committee, Chicago Association of Commerce, and he is a member of the Union League Club, Exmoor Country Club and Medinah Country Club.

Mr. Frank Guy succeeds Mr. L. C. Bihler, who has been made assistant to the president and general traffic manager of the Carnegie Steel Company, a steel corporation subsidiary. Mr. Guy has been assistant eastern traffic manager of the Universal company since 1912. He is a member of the transportation committee, Portland Cement Association; highway and bridges committee of the Pittsburgh Chamber of Commerce; Traffic Club of Pittsburgh.

Road Show Queen Rides a Caterpillar

Miss Lily Damita, starring with Ronald Colman in The Rescue and The Bridge at San Luis Rey, who was acclaimed Queen of the Road Show at Cleveland, during her personal appearance in that city. "Good Roads lead to Good Movies," said Miss Damita, "and both are great educators and instruments of peace and understanding." This is the first "Caterpillar" Ten of the line and already famous as the most traveled and viewed tractor in the world. It has traveled over 10,000 miles and has been seen by over 1,000,000 people. Gov. C. C. Young's daughter unveiled it at California State Fair. "Jimmy" Walker unveiled it at Eastern States Exposition.

New Appointments

George Haiss Mfg. Co., Inc., of New York City, announce several new appointments as distributor representatives. The list includes:

Holmes-Talcott Co., East Hartford, Conn.; West Springfield, Mass.

Contractors Equipment Co., Fort Wayne, Ind., J. J. Stockberger, Mgr.

W. C. Caye & Company, Atlanta, Ga.

C. Taylor Handman Co., Cincinnati, O.

Westinghouse Elects Robertson Chairman of Board of Directors

At a recent meeting of the Board of Directors of the Westinghouse Electric and Manufacturing Company held in New York City, Mr. Andrew Wells Robertson, president of the Philadelphia Company, was unanimously elected chairman of the board of directors.

Mr. Robertson is a graduate of Allegheny College, Meadville, Pa., and took a law degree from the University of Pittsburgh in 1910. He served as General Attorney for the Philadelphia Company of Westinghouse for several years, and was elected to the presidency in 1926. He is a prominent member of the Pittsburgh Chamber of Commerce, and is well known in the city's public affairs. His new office will demand his entire time, and his headquarters will be located in Pittsburgh.

At the same meeting which elected Mr. Robertson, Mr. Henry Bedinger Rust, president of the Koppers Company and an official in many other companies, was elected as a director of Westinghouse. He also is located in Pittsburgh, with offices in the Union Trust Building.

Mr. Paul D. Cravath, general counsel of the Westinghouse Company, has been serving as temporary chairman of the board since the death of Mr. Guy E. Tripp, in 1927. He will continue in the capacity of general counsel.

The F. C. Austin Foundation

College Scholarships to Train Business Executives

THE name of Frederick C. Austin is too well known in the highway field to need introduction as a manufacturer of road machinery, but in the establishing of a foundation for the building of men, he appears in a new role.

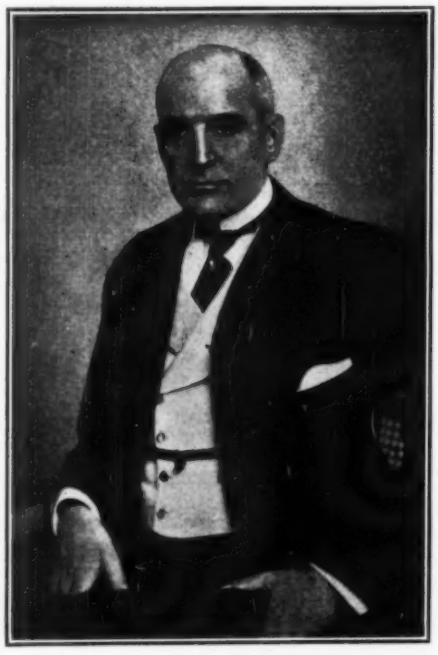
All of our readers, both those who have known Mr. Austin personally and those who only know his name, will be interested in the unique gift which he has made to Northwestern university. A property valued now at more than $3,000,000, and which will eventually reach many times that amount, has been turned over to the university, the income from which will be used for the training of business executives.

Mr. Austin is convinced that in future generations the greatest form of organized human activity will be in business. He has in mind primarily manufacturing and finance, but he also recognizes the importance of all other phases in the production and the distribution of commodities. He appreciates the importance of the learned professions, but feels that more has been done to select and to train men for these fields than for business.

In a statement which Mr. Austin gave out he says: "Colleges and universities from time immemorial have specialized in training men for the arts and professions, and the business world has been allowed to go it blind in training its executives. There is as much technique to it as there is to any science, and my desire is that all my holdings shall go to launching a nationwide movement in education for developing not only the executive abilities of youths but also to train them in the science of leadership. There will be technical instruction in the chosen fields of business, the same as there is special training for the dentist, the eye, ear, nose and throat specialist, or the practioner of corporation law. * * * Each man will be given the four year course to be provided by Northwestern university under the terms of the gift, and then he shall have a year of travel and study abroad to acquaint him with world conditions, world markets and the varying types of people. He will then be ready for active business."

It is not Mr. Austin's idea that these scholarships will be awarded only to boys in need of financial aid, but rich or poor young men alike will be allowed this special training, the amount awarded in each case to be decided according to the needs when the students are chosen.

In discussing this gift, President Scott of Northwestern said, "The university not only assumes the responsibility for selecting the F. C. Austin scholars, but also for directing their training. It is not likely that the time will ever come when all the business executives of any nation will be limited to those who have been formally selected and trained for such positions. But such organized efforts as those now being established by Mr. Austin will increase the number of competent executives and will assure more efficient administration and accordingly greater service to all the people of America."



F. C. Austin

Dr. Scott said he believed there were many factors entering into Mr. Austin's decision in making Northwestern administrator for this foundation. He pointed out that the locations of the Northwestern Chicago and Evanston campuses are such as to insure permanence over a long period of time. The fact that the university was established under the laws of the State of Illinois prior to 1880 grants to it exemption from taxation, and this exemption and the fact that university trustees give their services without compensation, insures a much greater expenditure for the scholarships than could be derived under a privately established trusteeship.

Another feature contributing to the successful administration of this fund, and the one on which its success depends, is the method of selecting the students who are to be the beneficiaries. The method of choosing these students Mr. Austin has left entirely to Northwestern. His gift has been made quite free from stipulations and in terms so simple as to admit of no entangling technicalities. Dr. Scott stated, however, that about seven years ago, under the able direction of Professor L. B. Hopkins (who has since become president of Wabash College), a personnel department was established at Northwestern University as an aid in the proper selection of the students and that at this time there are connected with this department eight persons, not on the teaching staff, who devote their entire time to it. Dr. Scott believes that the fact that this department has been doing such excellent work for so long was also taken into consideration by Mr. Austin in making his gift. He had spent his active business life and met with success in Chicago, and so it was in this part of the country that he wished this foundation established.

As stated before, Mr. Austin's gift was made in simple terms and without stipulations. He realizes the difficulty of character education, and feels that in some way ethical acts must be dominant. In a letter which he wrote to Dr. Scott this very interesting paragraph appears:

"I desire that scholarships shall be given without reference to religious faiths, or sectarian or denominational affiliations, but I feel that students should be surrounded as far as practicable with influences which will cause tnem to acknowledge a Divine Person and to recognize God as a living principal controlling the destiny of the universe including all mankind."

Frederick C. Austin was born on a farm near Skaneateles, N. Y., June 2, 1853, and received his schooling in his native state. He did not attend college, but came west when about eighteen years old and entered the employ of his uncle, Mr. H. W. Austin, in Chicago, who had established a hardware manufacturers' agency in 1858. He traveled for his uncle for some time and then joined his father in Kansas City, Mo., where he was engaged in a business similar to that of Mr. H. W. Austin in Chicago. Later he returned to Chicago and became a partner of the Goulds, who had purchased the business of Mr. H. W. Austin about 1883. At one period this firm was Goulds, Austin and Caldwell.

As a natural step after his many years of experience in selling machinery he founded the F. C. Austin Manufacturing Company at Harvey, Ill.

Since 1920, Mr. Austin has devoted his time to his investments. His wife died about five years ago and he has no children.

Mr. Austin was a great admirer of both the late Judge Elbert H. Gary and the late James A. Patten, two of the most distinguished alumni of Northwestern university, and he believes that in some way these two great business executives were helped in their careers by their training, years ago, at Northwestern.

For many years to come men in the road field, as well as other lines, will watch with interest the results of the work being done by Northwestern university under the F. C. Austin Foundation.

Barney Google & Spark Plug The Play's the Thing

As one of the entertainment features at the recent meeting of the Robert Bosch distributors in New York City, a play was presented by members of the organization, which kept the audience in gales of laughter the entire evening, according to reports. So good was this play, a second presentation was asked for, and it was repeated at a later date at the Stevens Hotel in Chicago.

PREMIERE PERFORMANCE OF
BARNEY GOOGLE AND SPARK PLUG
GIVEN BY
ROBERT BOSCH MAGNETO CO. INC.
HOTEL ASTOR NEW YORK JANUARY 4, 1929

The Cast

Barney Google	Mr. W. L. Fetherston
Alex	Mr. W. J. Dowling
Watson W. Wetherby	Mr. A. F. Wagner
Mr. Blanchard	Mr. L. F. Acker
Clarence Calkins	Mr. J. H. Connor
Deacon Calkins	Mr. A. J. Poole
Miss Lotta Dough	Miss Selma Silver
Blanche	Miss Betty R. Spinrad

"Barney Google and Spark Plug" was the classic title of this histrionic presentation, and as noted, it was given for fun and entertainment. But, as the name implies, it had to do with the trials and tribulations of Mr. Barney Google (symbolizing the average dealer) and the need for good spark plugs, aided and abetted by the usual love interest and the comedy of the typical garage mechanic.

A clever way, indeed, to tie up work with play, for all through the coming year, the distributors will think back with amusement on this evening of fun, and the points made in the play will remain as perfectly good talking points in their business.

The entire play was written, staged and acted by members of the Robert Bosch organization, the cast being recruited from the sales department, which promoted a splendid spirit of cooperation and friendship in the company.

The T. L. Smith Company Buys Kwik-Mix

The T. L. Smith Company of Milwaukee announces the purchase of the Kwik-Mix Concrete Mixer Company, Port Washington, Wis. The entire plant of the company at Port Washington will continue to be operated as heretofore with the exception of the business office, which will be combined with the T. L. Smith Company Milwaukee office.

With the acquisition of the various Kwik-Mix models, the T. L. Smith Company now has one of the most complete line of mixers in the world, ranging from the 2½-S size to the 112-S tilter, the world's largest mixer. The models include a machine for every conceivable mixing job and have a wide price range that will meet the purse of any contractor.

The T. L. Smith Company is one of the independent divisions of the National Equipment Corporation.

Soviet Russia Inaugurates New Motor Transportation System

The Amtorg Trading Corporation, authorized agents for the Soviet Government, have placed a large order for motors with the Hercules Motors Corporation of Canton, O. The contract calls for the delivery of several hundreds of power plants over a period of the next ten months.

This is believed to be the first step on the part of the Soviet Government in an organized plan to motorize Russia, as the new motors are to be used in equipping a fleet of trucks. Owing to the great distances to be covered, the Soviets have found that good roads, trucks and buses are the quickest and most economical means of securing adequate national transportation, and an extensive road building program is contemplated.

The current order is the first on the new program to be given for American-made engines, although during the past few years the Amtorg Trading Corporation has been a steady purchaser of Hercules engines for industrial equipment. The engines selected in this instance represent an advanced type of heavy-duty, six-cylinder motors for commercial truck purposes, specifications calling for six-cylinder 4⅜x4¾ model, now in use by many American manufacturers.

Announcing Craig, Skidmore & O'Brien, Inc.

Operating under the name of the above incorporation, these practicing engineers offer their services in consultation, development and management, appraisal, investigation, design and construction. Mr. George W. Craig, serving the company as president, was formerly city engineer of Omaha, Neb., and was a member of the firm of Rosewater and Craig of that city; later he became city engineer of Calgary, and recently has been engineer of the Asphalt Association.

Mr. Morgan O'Brien, vice-president of the new company, has been consulting engineer for the city of Decatur, Ill., a member of the engineering department of the I. C. R. R., chief engineer of the Illinois Traction System on construction, and chief engineer of construction for the A. E. Staley Manufacturing Company.

The secretary-treasurer for this firm will be Mr. Hugh W. Skidmore, president of the Chicago Paving Laboratory, Inc.

The address of the new company will be 308 W. Washington St., Chicago, Ill.

Via the Air Route

John Jay and H. F. Saxton of the Iowa Manufacturing Company, manufacturers of Cedar Rapids Rock Crushing equipment, and T. M. Deal, Sales Manager of the Speeder Machinery Corporation, manufacturers of Speeder cranes, shovels and trailers, both of Cedar Rapids, Iowa, fooled Old Man Winter with his Iowa snow and below zero weather when they resorted to the use of an airplane to make a hurried trip to Cleveland from Cedar Rapids in order to be in attendance at Dealers' Day Conference of the National Road Show, Saturday, Jan. 12.

The trip was made in the six-passenger Stinson Detroiter owned by the Cedar Rapids Airways Company. Dan F. Hunter, General Manager of the Cedar Rapids Airways Company, acted as pilot.

Manitowoc Engineering Acquires Patent Rights

Manitowoc Engineering Works of Manitowoc, Wis., have purchased the Hoist & Derrick Co. for clamshell buckets. The Buffalo-Manitowoc clamshell buckets will be manufactured and sold by the purchaser.

Representatives or New Lines Wanted

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives for their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New York corporation wishes to establish agencies throughout the country, prefer men specializing in heating and ventilating equipment.

A manufacturer of paving expansion joints is looking for distributors for northern California territory.

New York corporation, producing complete line of coal-tar products, wishes to make dealer connections throughout the country.

Manufacturer of building specialties wishes to establish distributors throughout the country. Manufactures concrete reinforcements and metal lath; Reed clips, form spacers, continuous column tie, continuous chair stirrup, beam bar spacers, slab bar spacers, continuous Hi-chair, continuous anchor slot, sleeping spacing anchor, humpback hairpin clip, lath hanger, stone anchors, straight wire lengths and special wire lengths.

A contractor's superintendent, located in Florida, would like to represent some road equipment manufacturers in his territory.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Manufacturers' representatives located in New York would like to add line of heavy contractors' equipment of established reputation, other than the lines now handled by them. They would like exclusive sales rights for such equipment.

New York company would like to represent manufacturers not already established in eastern market, or who would like to make a change in their sales arrangements.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

A man of many years' experience in the machinery business in the south would like to make a business connection for the sale of road machinery equipment.

Eastern Distributor handling Brick and Clay Products, and similar commodities, would be pleased to get in touch with manufacturers desiring eastern representation.

Machinery distributor established in Porto Rico and Santo Domingo would be pleased to make arrangements to take on new lines in these territories.

Executive with 20 years' experience in selling contractors' and builders' machinery and equipment, is starting new organization and would like to hear from manufacturers desiring representation in Northern California.

Palouse Tractor and Equipment Co. Takes Western Territory

According to newspaper story, the subdivision of the territory formerly served by the Hofius-Ferris Company in the far west, a new company has been organized to take over Whitman County, Washington, and Clearwater and Latah counties in Idaho, as tractor and equipment distributing headquarters. The new company will incorporate for $50,000 and operate under the name of The Palouse Tractor and Equipment Company.

H. W. Fairweather and L. J. Acuff, former residents of Spokane, become managers of the new company and will reside in Pullman, Washington. They were formerly interested in the Hofius-Ferris Company. Mr. L. C. Thomas, who had been serving as manager of the Pullman branch of Hofius-Ferris, will also be connected with the new organization.

Speeder Machinery Dealers Meet in Conference

The Speeder Machinery Corporation, Cedar Rapids, Iowa, manufacturers of Speeder cranes, shovels and trailers, held its annual Dealers' Day Conference in the general offices at Cedar Rapids, Saturday, Jan. 19, 1929. Speeder dealers from all parts of the United States and Canada were in attendance.

The trip to the factory from the Cleveland Road Show by the dealers was made in a special Pullman chartered by the Speeder corporation.

The Dealers' Day Conference was followed by the annual Sales Convention, which was attended by all Speeder sales representatives.

Uniform Name Adopted for International Cement Companies

According to a statement issued by Mr. H. Struckmann, president of the International Cement Corporation, all subsidiaries of this corporation in the United States, as well as the Cuban Portland Cement Corporation, Argentine Portland Cement Company and the Uruguay Portland Cement Company, will be known as the Lone Star Cement Company. This change in no way affects the management, policies or products, but is one in name only.

The name, now universally adopted, had its origin about 30 years ago in the "Lone Star State," when a small mill in Texas began to produce Lone Star Cement, and which was to grow into a chain of 13 mills with an annual capacity of 20,000,000 barrels, under the direction of the International Cement Corporation, formed in 1919, when the annual capacity was 2,900,000 barrels.

While each Lone Star Cement Company is an independent organization, the resources of the International Corporation are available for scientific research and support in all modern practices. "Incor," a perfected high-early-strength Portland Cement is one of the achievements of the International System. This product was used in the construction of the Moffat Tunnel, and also in the Arlington Memorial Bridge, over the Potomac River from Washington, D. C., to Virginia, now under construction.

The mills of the Lone Star Companies are located in Alabama, Indiana, Kansas, Missouri, Louisiana, Pennsylvania, Texas, New York and Virginia, as well as the foreign countries previously mentioned. Cooperation between these companies enables them to render rapid, dependable service.

Personal Mention

Word has been received that the resignation of Mr. Rogers D. Edwards has been tendered the C. D. Edwards Mfg. Co., to take effect March 1st. Mr. Edwards has been active in the management of the Edwards Company for a number of years prior to the sale of his interests to the new organization formed from the consolidation of the Ryan Manufacturing Corporation and the C. D. Edwards Manufacturing Company, manufacturers of road machinery.

A Change of Address

The Southern Iron & Equipment Co., rebuilders of locomotives, cars, shovels, etc., who for the past twenty years have had their offices in the Grant Bldg. at Atlanta, Ga., have moved their general offices from the Grant Bldg. to their works at Hemphill Ave. and Southern Railway, Atlanta.

The Dow Chemical Company of Midland, Mich., announce the appointment of Mr. Donald Williams as assistant sales manager to succeed Mr. S. W. Putnam, whose resignation was accepted in December.